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(12) **United States Patent**
Oshima et al.

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(54) **COMMUNICATION METHOD**

(71) Applicant: **PANASONIC INTELLECTUAL PROPERTY CORPORATION OF AMERICA**, Torrance, CA (US)

(72) Inventors: **Mitsuaki Oshima**, Kyoto (JP); **Koji Nakanishi**, Kanagawa (JP); **Hideki Aoyama**, Osaka (JP); **Shinsuke Ogata**, Osaka (JP)

(73) Assignee: **PANASONIC INTELLECTUAL PROPERTY CORPORATION OF AMERICA**, Torrance, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **15/008,799**

(22) Filed: **Jan. 28, 2016**

(65) **Prior Publication Data**

US 2016/0149641 A1 May 26, 2016

Related U.S. Application Data

(63) Continuation of application No. 14/260,351, filed on Apr. 24, 2014, now Pat. No. 9,294,666.

(60) Provisional application No. 61/921,132, filed on Dec. 27, 2013.

(51) **Int. Cl.**
H04N 5/235 (2006.01)
H04B 10/116 (2013.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04B 10/116*** (2013.01); ***G06K 9/209*** (2013.01); ***G06K 9/22*** (2013.01); ***G06K 9/3208*** (2013.01); ***H04N 5/2257*** (2013.01); ***H04N 5/247*** (2013.01)

(58) **Field of Classification Search**
CPC . H04N 5/23203; H04N 5/235; H04N 5/2351; H04N 5/2621; H04N 5/247
See application file for complete search history.

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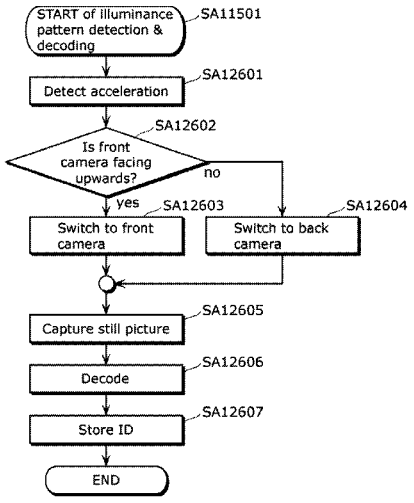
Primary Examiner — Tuan Ho
(74) *Attorney, Agent, or Firm* — Greenblum & Bernstein, P.L.C.

(57) **ABSTRACT**

A communication method used in a terminal is provided that includes a front camera and a back camera. The communication method includes switching between the front camera and the back camera according to an orientation of the terminal, and performing visible light communication by using the front camera or the back camera, which is selected in the switching. The performing of visible light communication includes capturing a first subject that is changing in luminance by using the front camera and obtaining a first image when the front camera is used, capturing a second subject by using the back camera and obtaining a second image when the back camera is used, and obtaining specified information that is related to the first subject or the second subject.

8 Claims, 48 Drawing Sheets



(51) **Int. Cl.**

H04N 5/225	(2006.01)
H04N 5/247	(2006.01)
G06K 9/32	(2006.01)
G06K 9/22	(2006.01)
G06K 9/20	(2006.01)

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* cited by examiner

FIG. 1

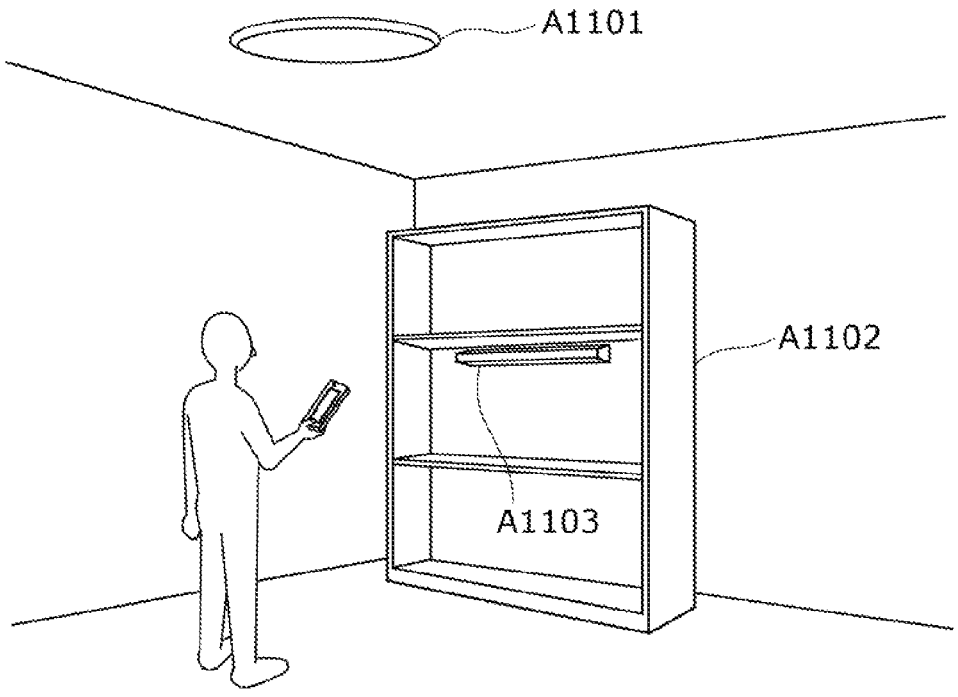


FIG. 2

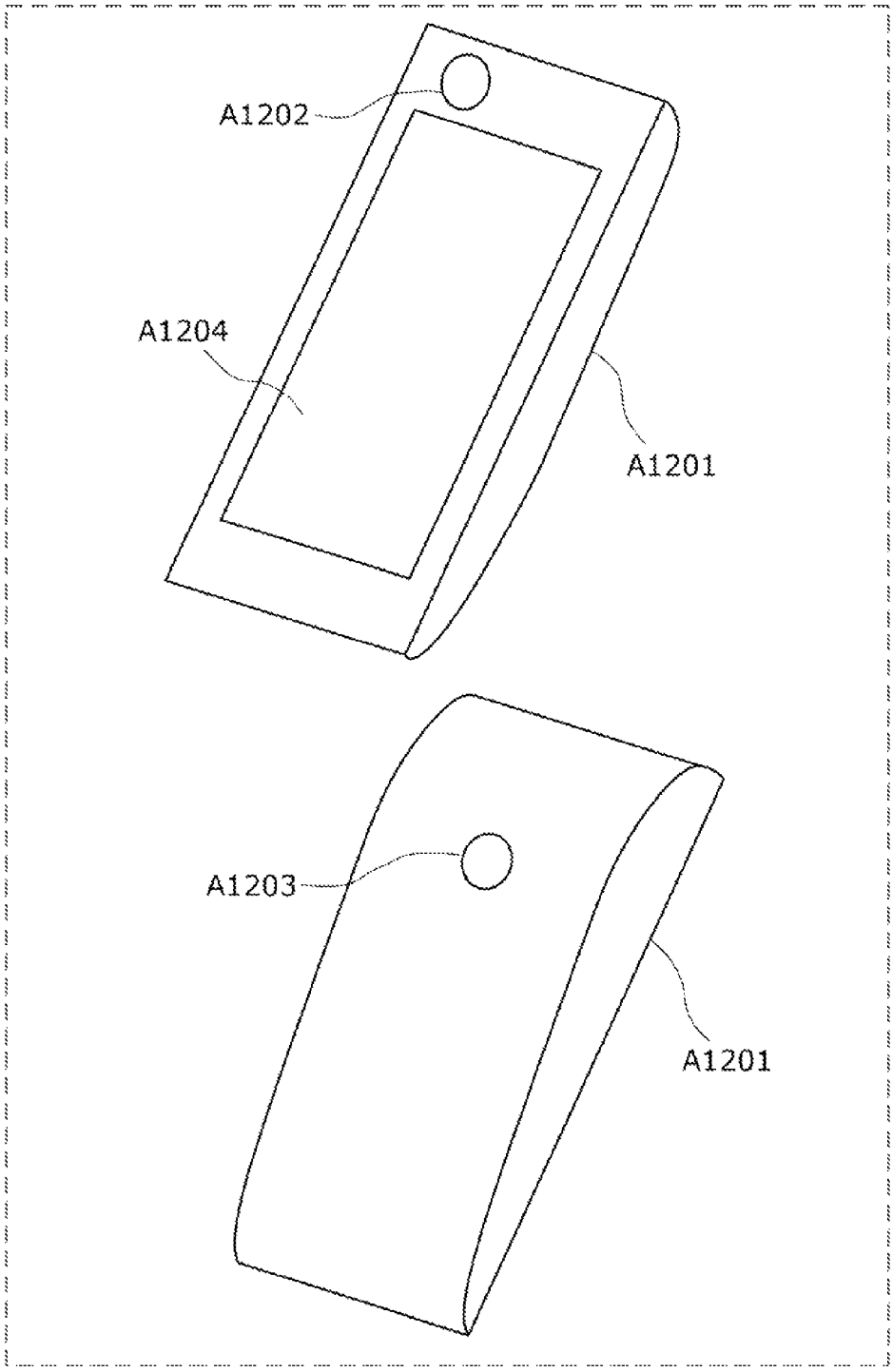


FIG. 3

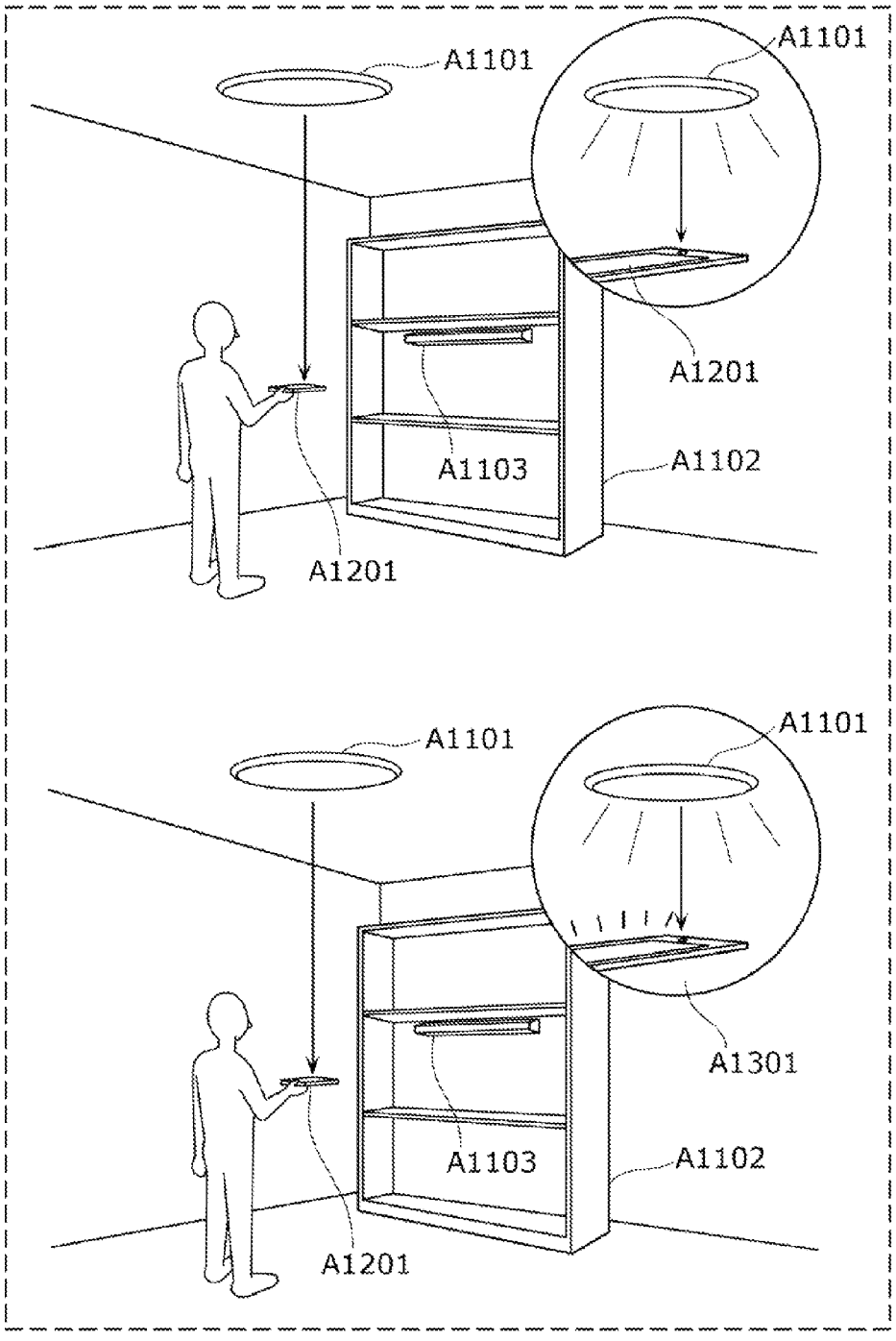

A1101
A1101
A1201
A1103
A1102
A1201
A1101
A1101
A1301
A1103
A1102
A1201

FIG. 4

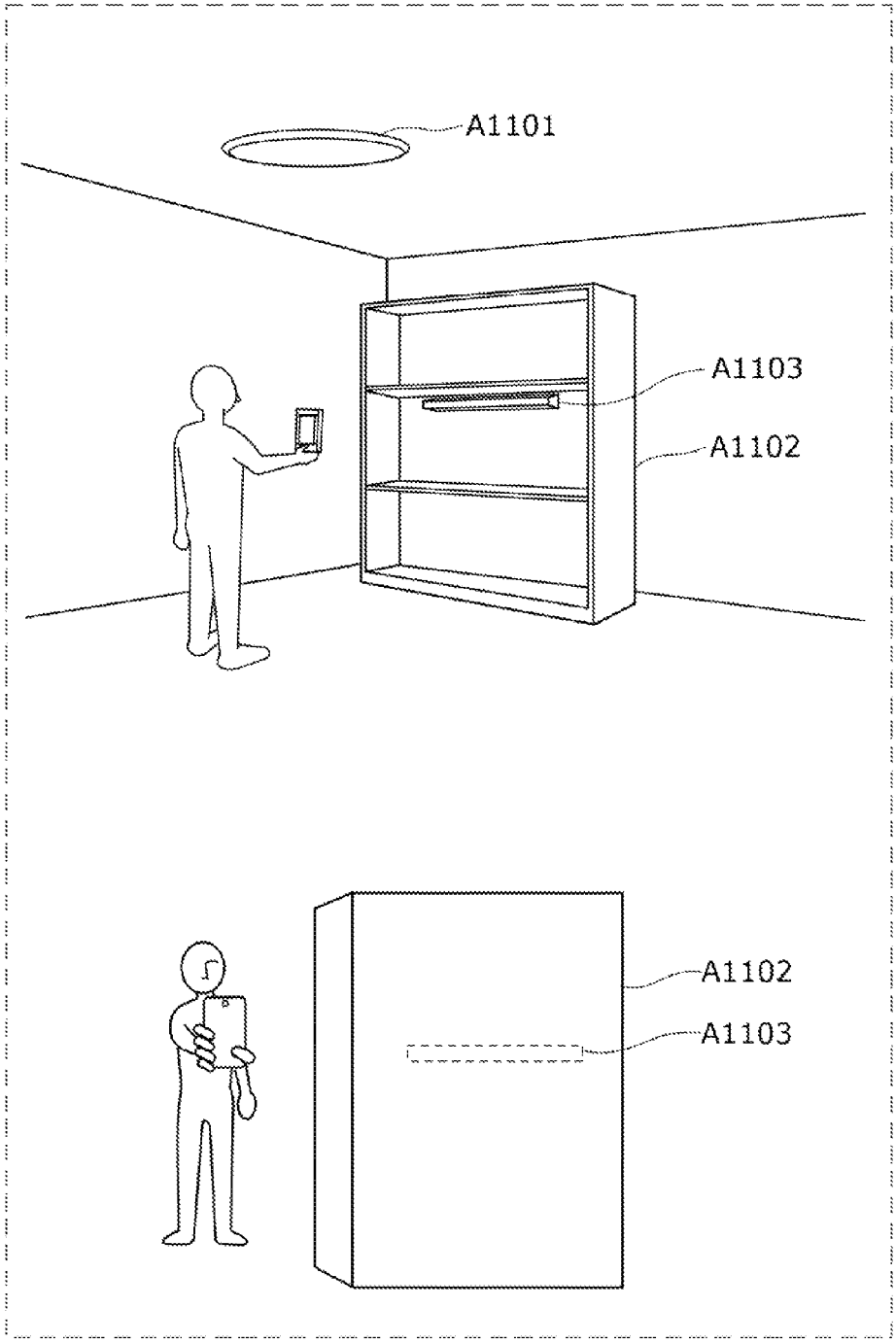


FIG. 5

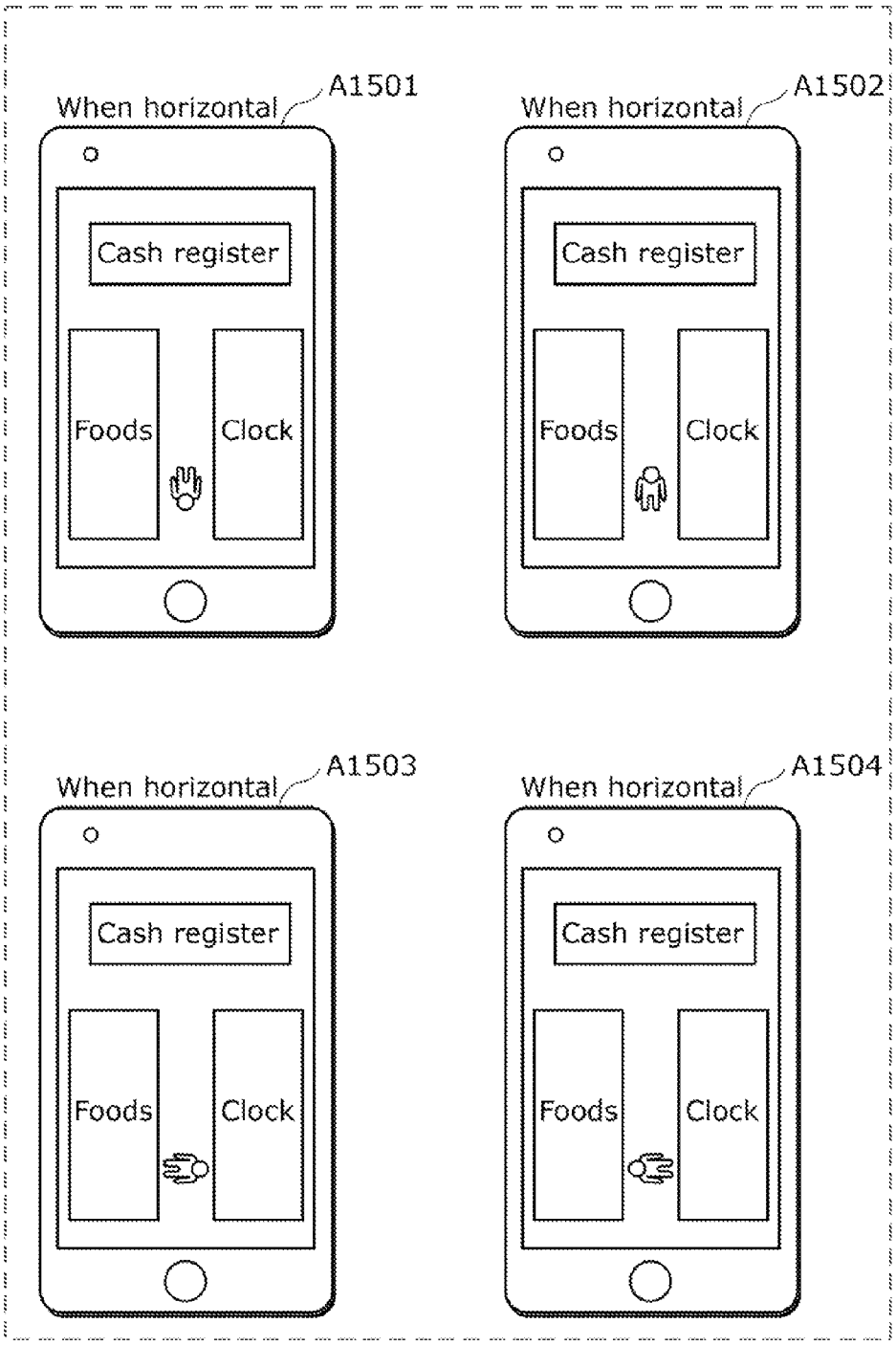
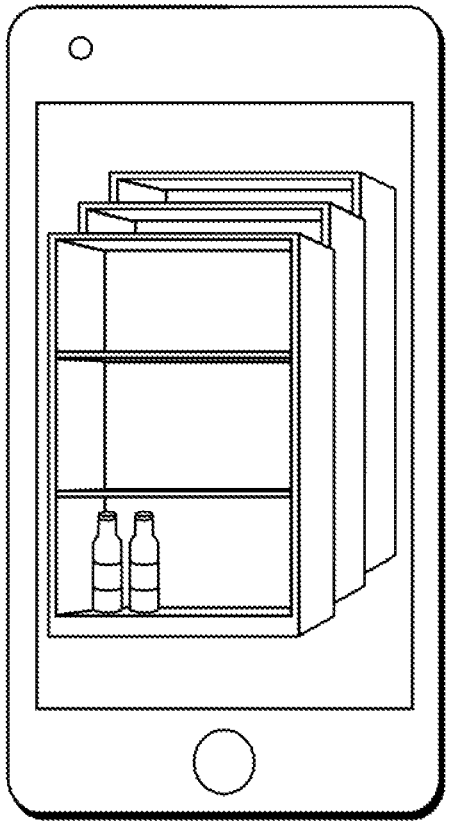

When horizontal
A1501
Cash register
Foods
Clock
When horizontal
A1502
Cash register
Foods
Clock
When horizontal
A1503
Cash register
Foods
Clock
When horizontal
A1504
Cash register
Foods
Clock

FIG. 6



(When vertical)

FIG. 7

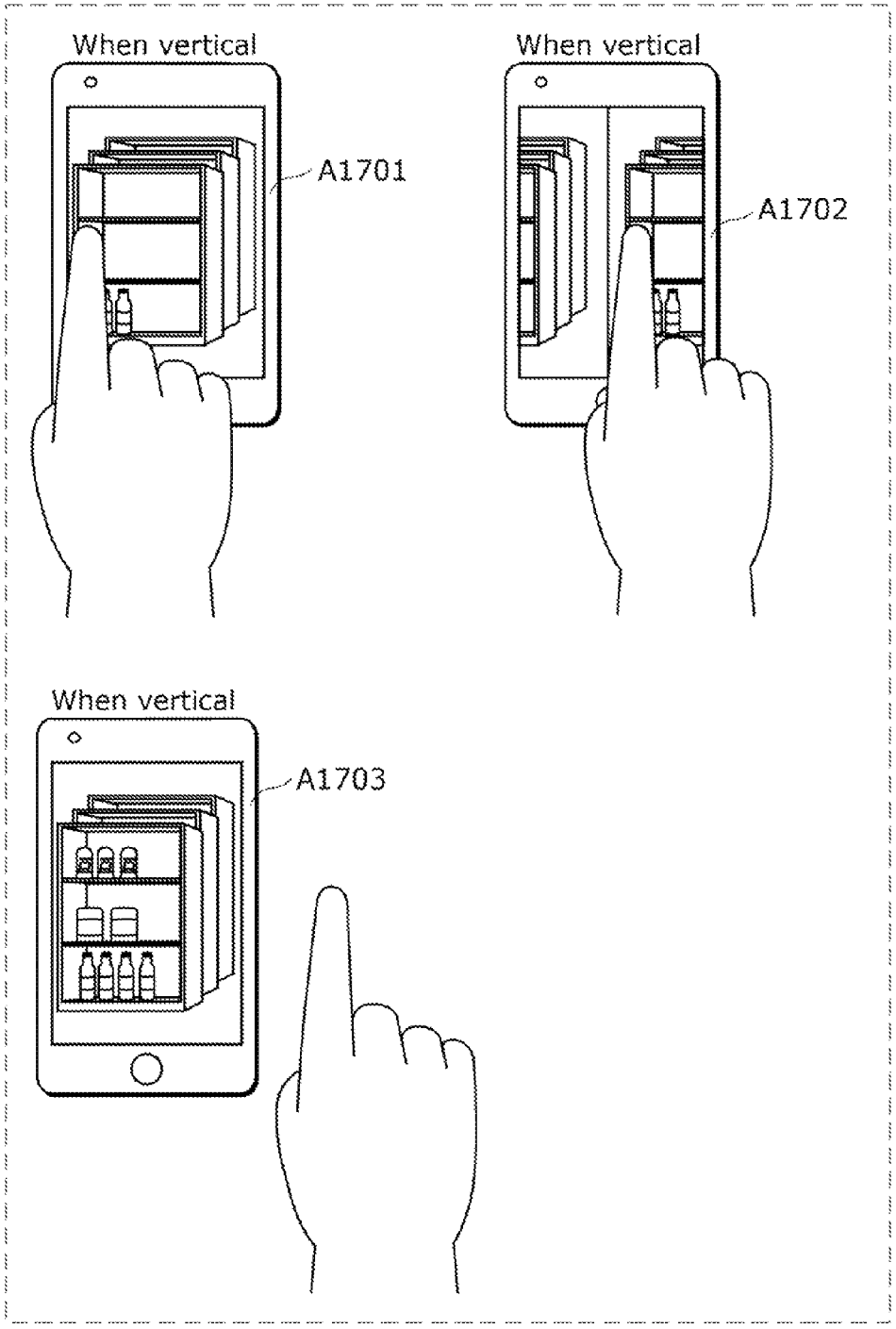

When vertical
A1701
When vertical
A1702
When vertical
A1703

FIG. 8

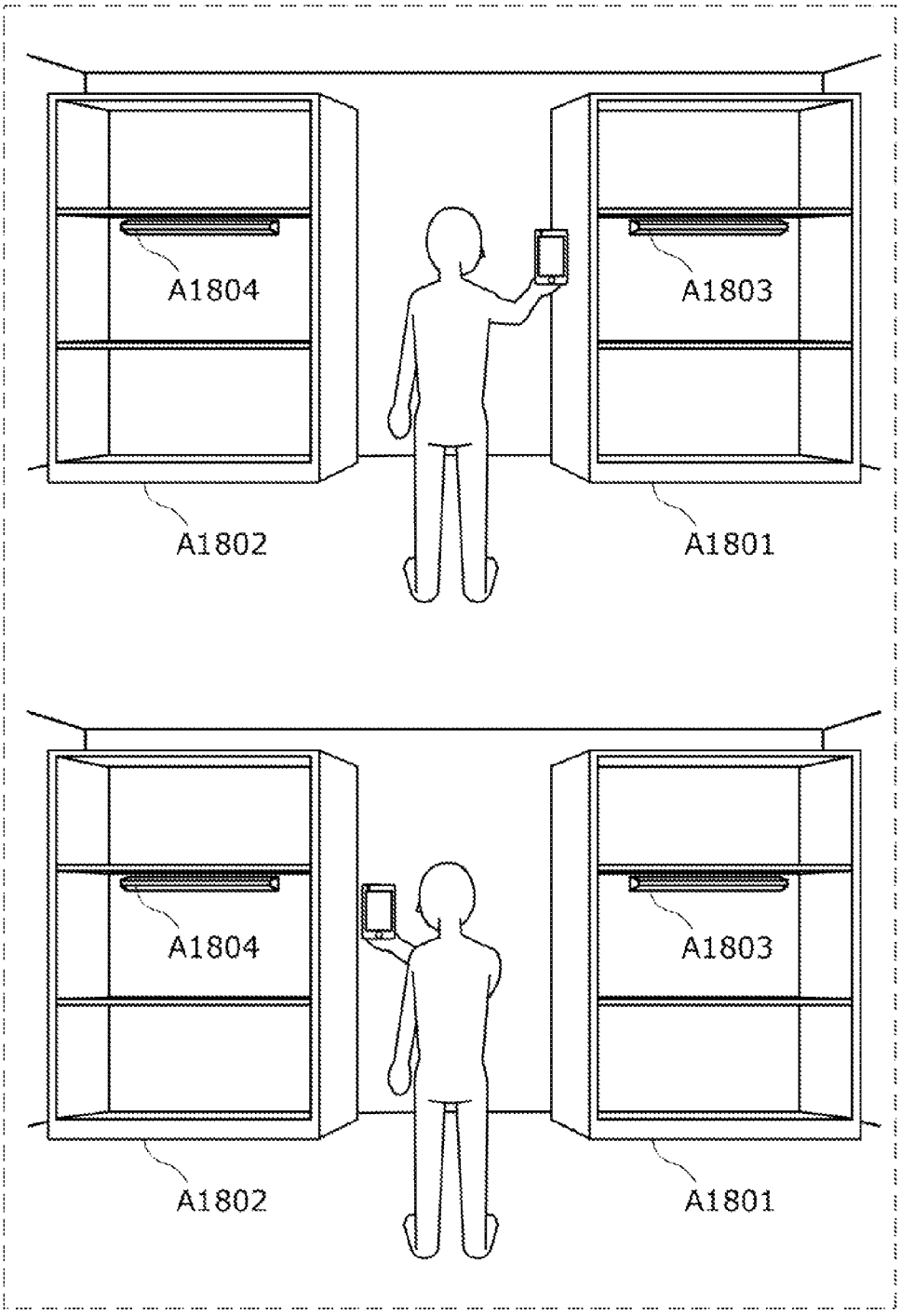


FIG. 9

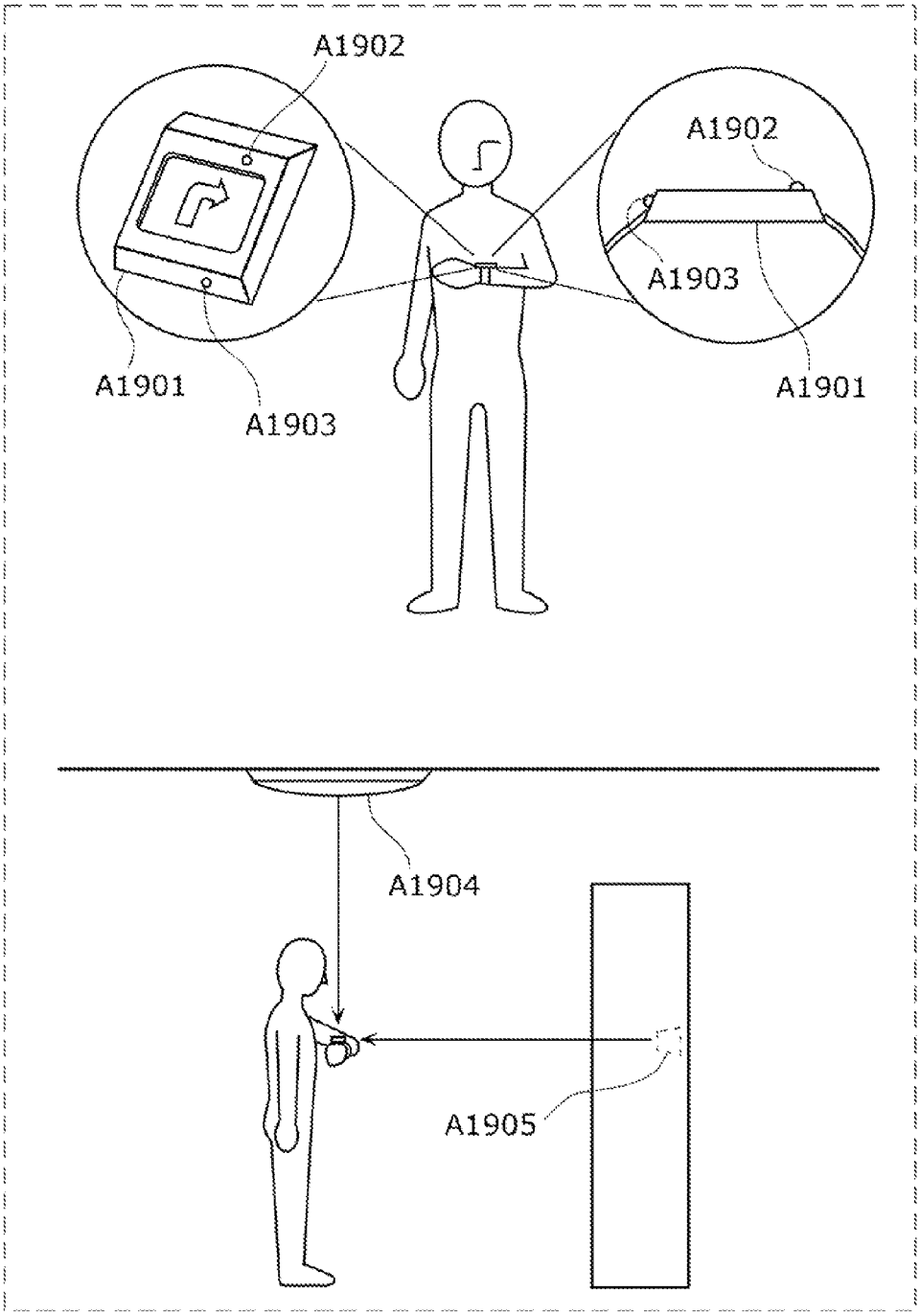


FIG. 10

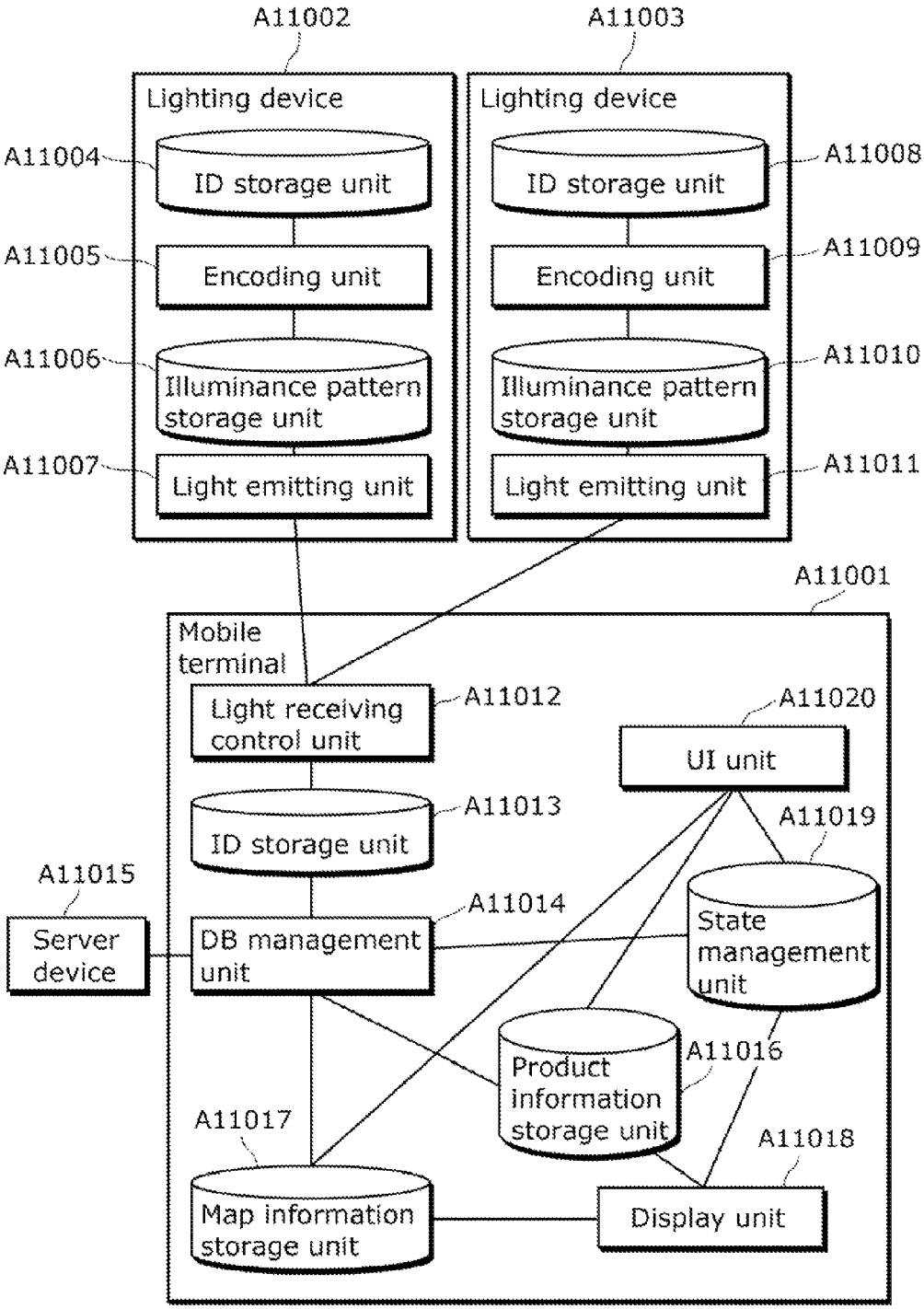

A11002
A11003
Lighting device
Lighting device
A11004
ID storage unit
A11008
ID storage unit
A11005
Encoding unit
A11009
Encoding unit
A11006
Illuminance pattern storage unit
A11010
Illuminance pattern storage unit
A11007
Light emitting unit
A11011
Light emitting unit
A11001
Mobile terminal
Light receiving control unit
A11012
A11020
UI unit
ID storage unit
A11013
A11019
A11015
Server device
DB management unit
A11014
State management unit
Product information storage unit
A11016
A11017
A11018
Map information storage unit
Display unit

FIG. 11

A11101 Validity flag	Drawing validity	TRUE
A11102 Rack exterior	Height of rack	1600 mm
	Width of rack	1200 mm
A11103 Rack interior	The number of shelves	3
	Height ratio of first shelf	0.3
	Height ratio of second shelf	0.35
	Height ratio of third shelf	0.35
A11104 Product type information	The number of product variations	3
	Length of image data of product type [0]	542
	Image data of product type [0]	(Binary)
	Height of product type [0]	120 mm
	...	
	Length of image data of product type [2]	542
	Image data of product type [2]	(Binary)
	Height of product type [2]	140 mm
A11105 Product stock information	The number of products	10
	Type number of product type [0]	0
	x coordinates of product type [0]	1
	y coordinates of product type [0]	2
	z coordinates of product type [0]	0
	...	
	Type number of product type [9]	2
	x coordinates of product type [9]	3
	y coordinates of product type [9]	1
	z coordinates of product type [9]	2

FIG. 12

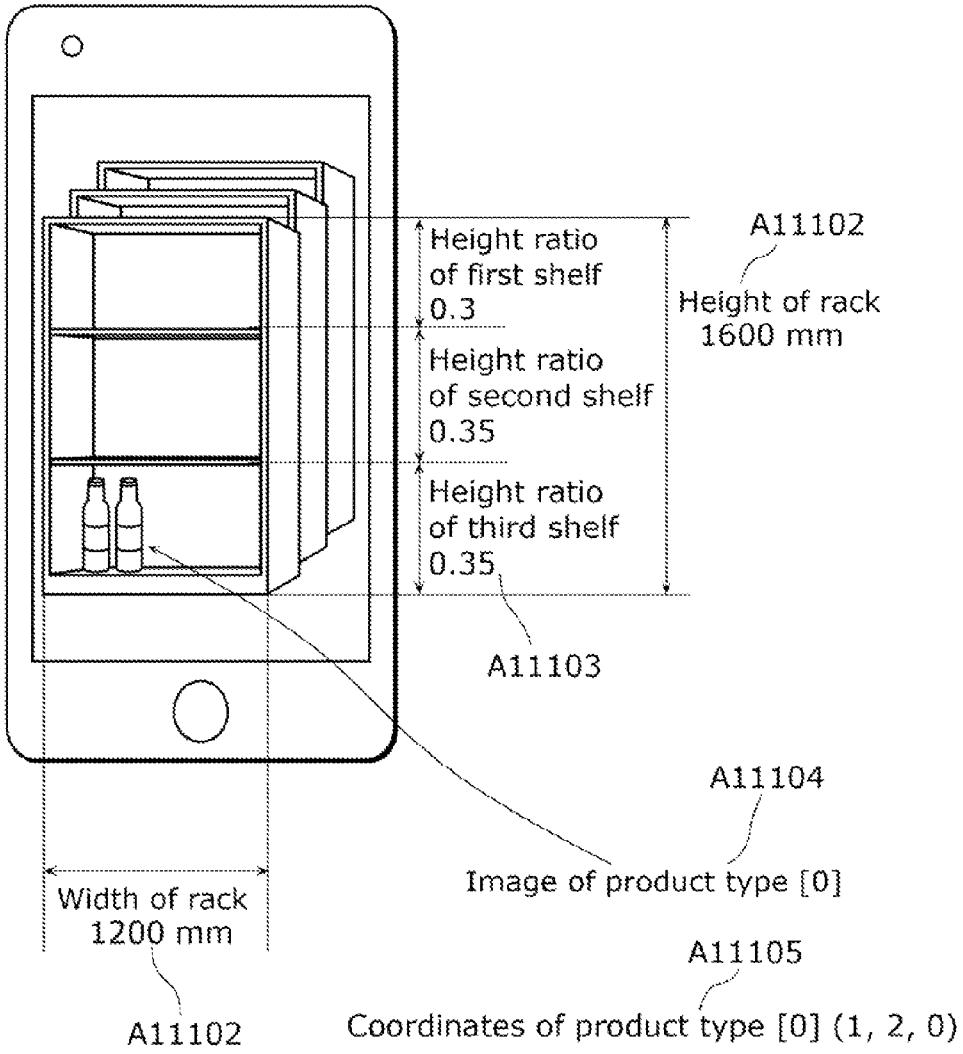


FIG. 13

A11301	Validity flag	TRUE
A11302	Data length of map image	400 kbyte
A11303	Map image	(Binary)

FIG. 14

A11601	Error flag	TRUE
A11602	Previous frame drawing type	Map information
A11603	Depth of display rack	0
A11604	Map offset X	0
A11605	Map offset Y	0
A11606	Previously-obtained ID	-1

FIG. 15

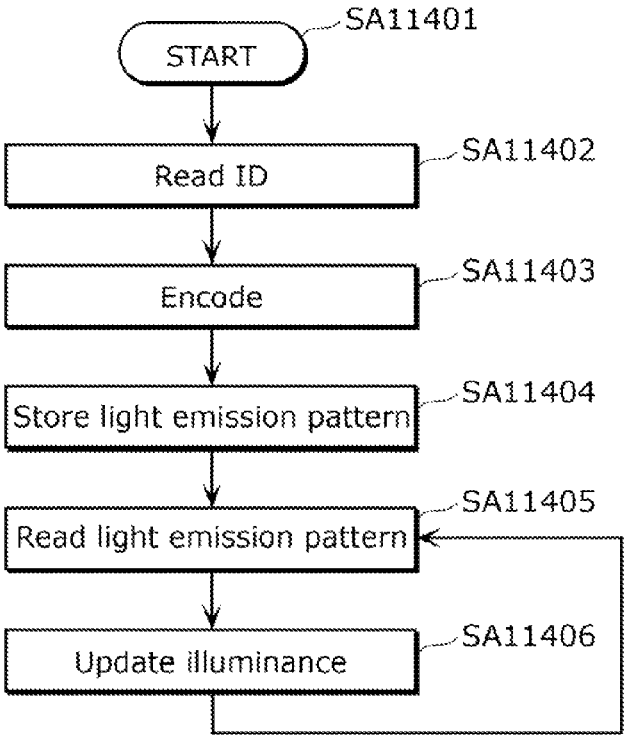


FIG. 16

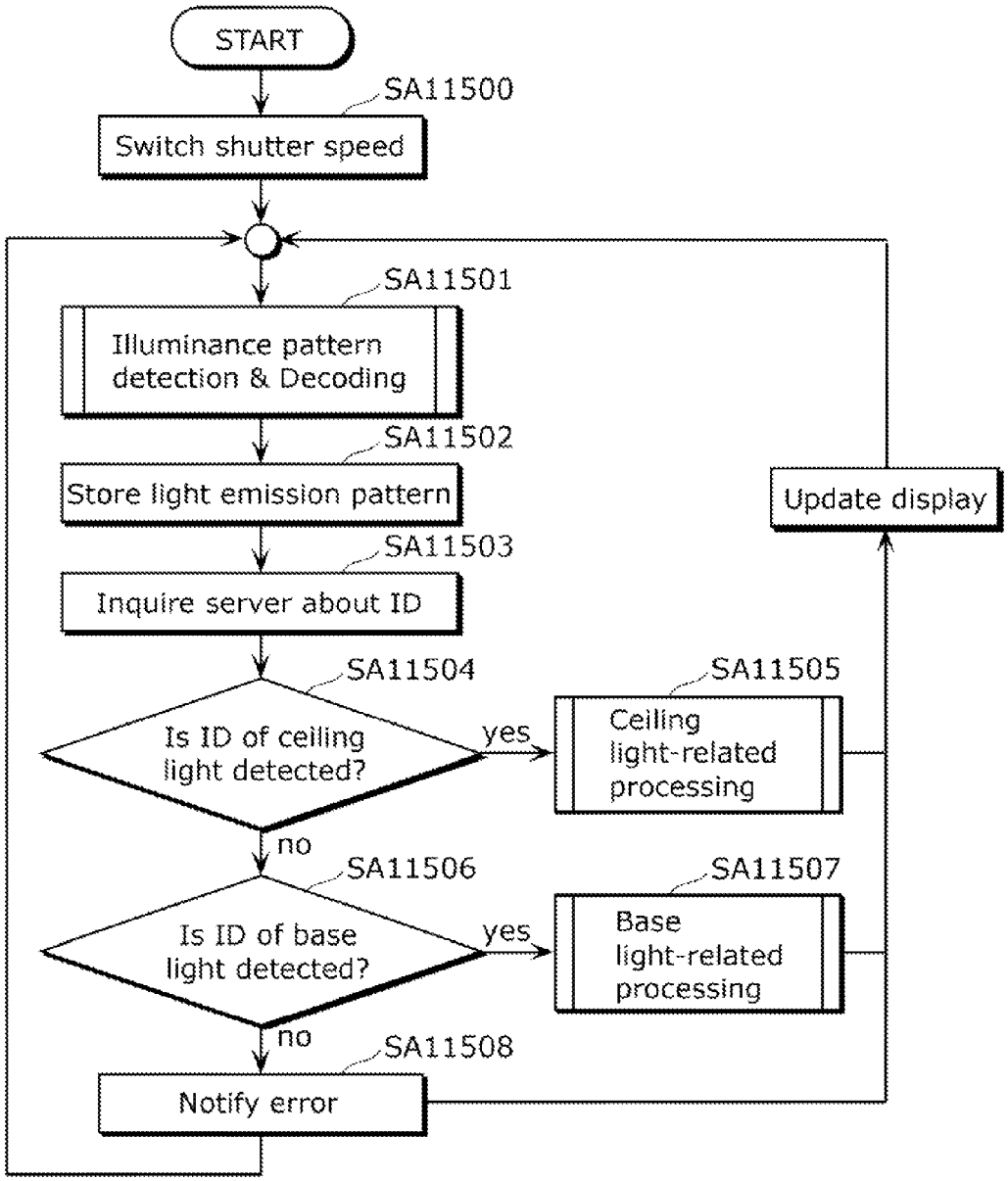

START
SA11500
Switch shutter speed
SA11501
Illuminance pattern detection & Decoding
SA11502
Store light emission pattern
SA11503
Inquire server about ID
SA11504
Is ID of ceiling light detected?
yes
SA11505
Ceiling light-related processing
no
SA11506
Is ID of base light detected?
yes
SA11507
Base light-related processing
no
SA11508
Notify error
Update display

FIG. 17

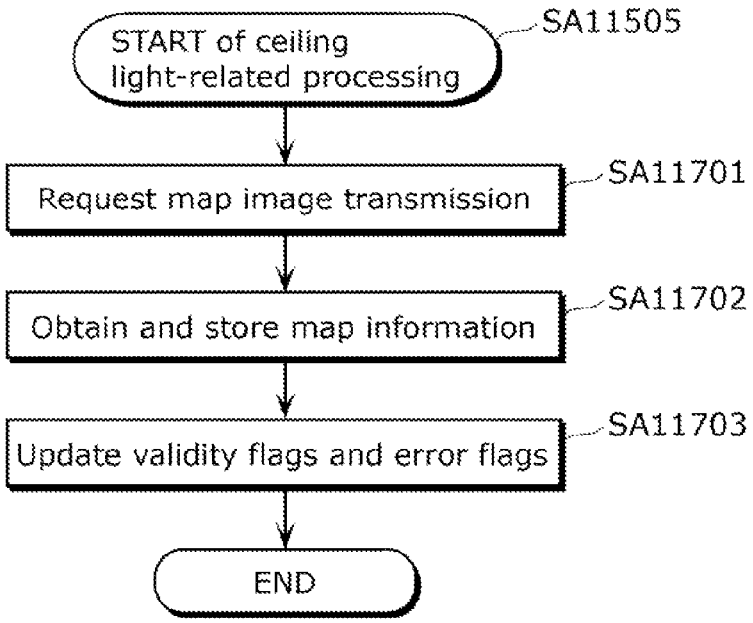

START of ceiling light-related processing
SA11505
Request map image transmission
SA11701
Obtain and store map information
SA11702
Update validity flags and error flags
SA11703
END

FIG. 18

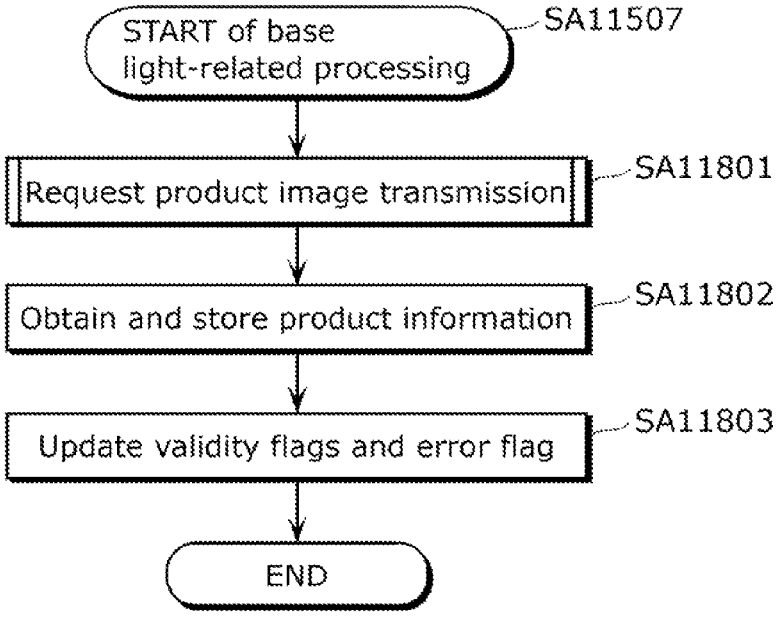

START of base light-related processing
SA11507
Request product image transmission
SA11801
Obtain and store product information
SA11802
Update validity flags and error flag
SA11803
END

FIG. 19

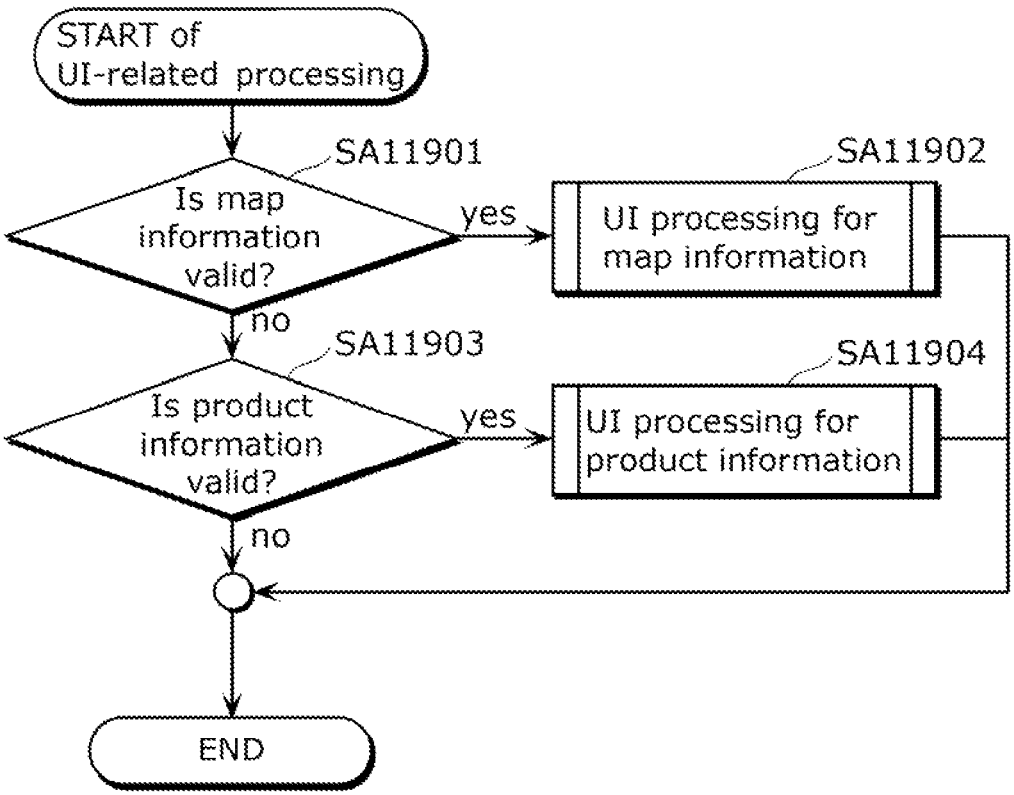

START of
UI-related processing
SA11901
Is map
information
valid?
yes
SA11902
UI processing for
map information
no
SA11903
Is product
information
valid?
yes
SA11904
UI processing for
product information
no
END

FIG. 20

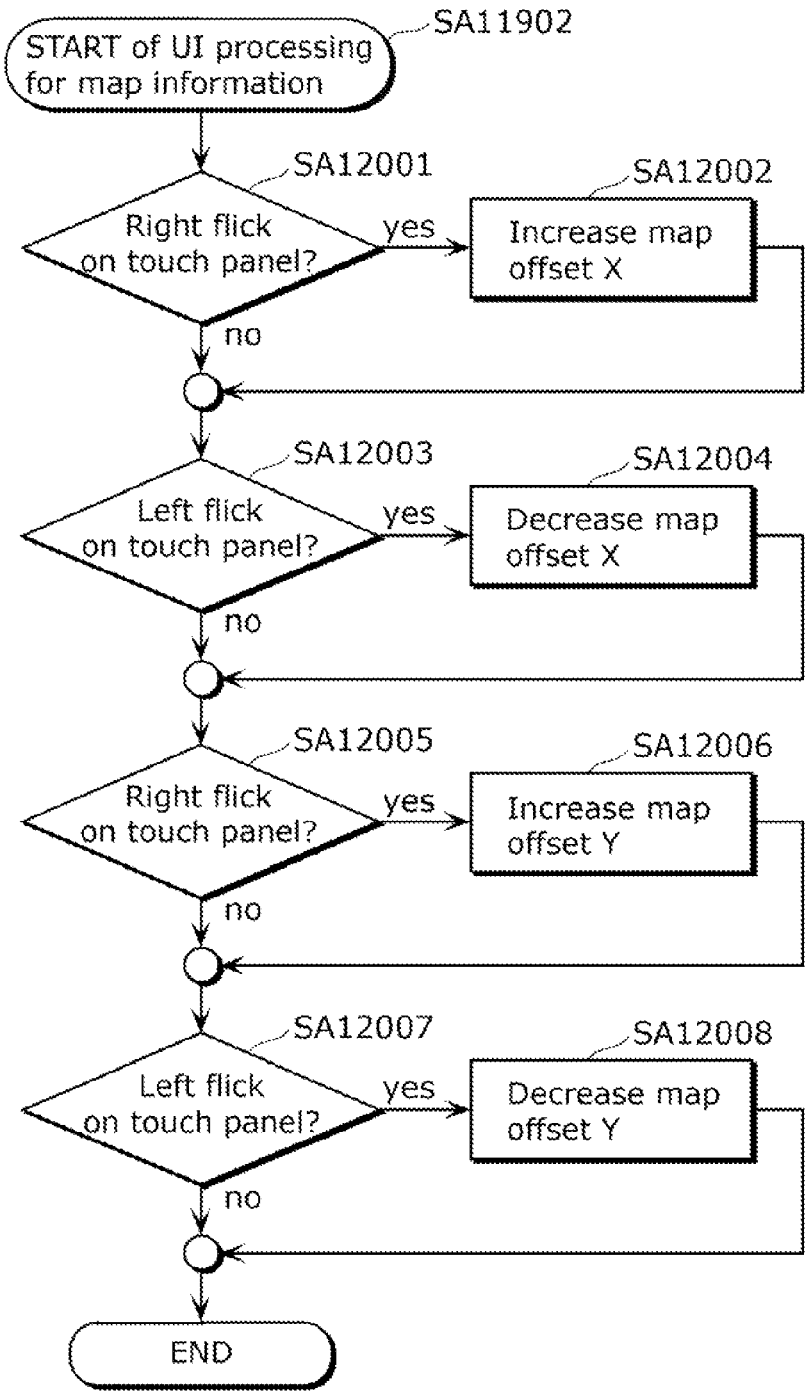

START of UI processing for map information
SA11902
SA12001
Right flick on touch panel?
yes
SA12002
Increase map offset X
no
SA12003
Left flick on touch panel?
yes
SA12004
Decrease map offset X
no
SA12005
Right flick on touch panel?
yes
SA12006
Increase map offset Y
no
SA12007
Left flick on touch panel?
yes
SA12008
Decrease map offset Y
no
END

FIG. 21

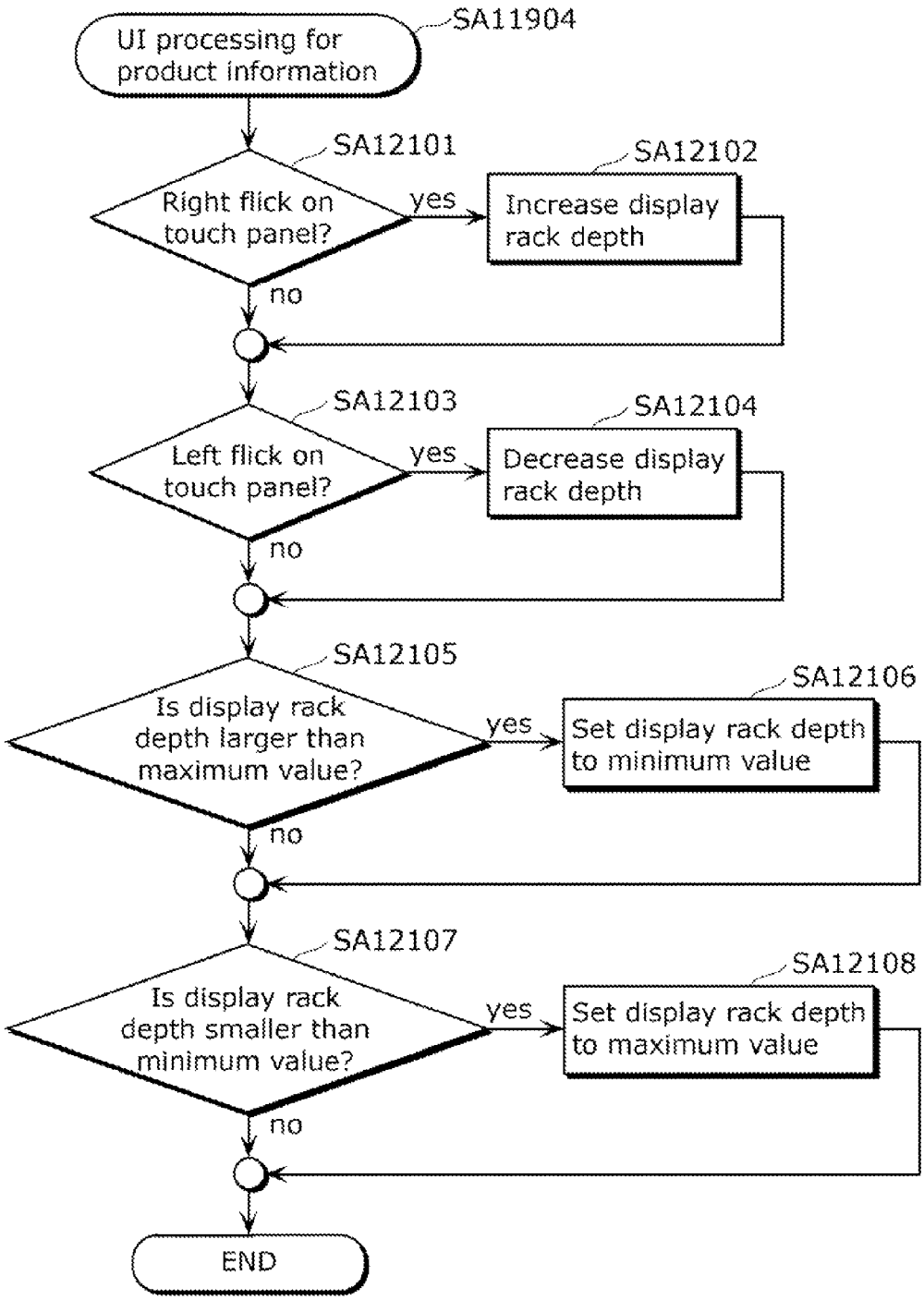

UI processing for product information
SA11904
SA12101
Right flick on touch panel?
yes
SA12102
Increase display rack depth
no
SA12103
Left flick on touch panel?
yes
SA12104
Decrease display rack depth
no
SA12105
Is display rack depth larger than maximum value?
yes
SA12106
Set display rack depth to minimum value
no
SA12107
Is display rack depth smaller than minimum value?
yes
SA12108
Set display rack depth to maximum value
no
END

FIG. 22

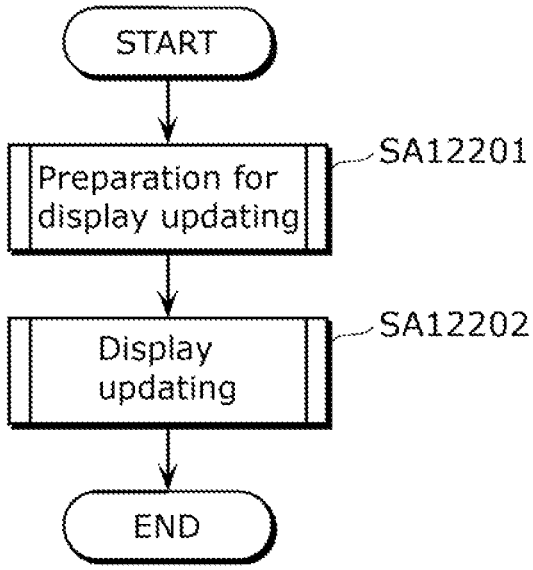

START
Preparation for display updating
SA12201
Display updating
SA12202
END

FIG. 23

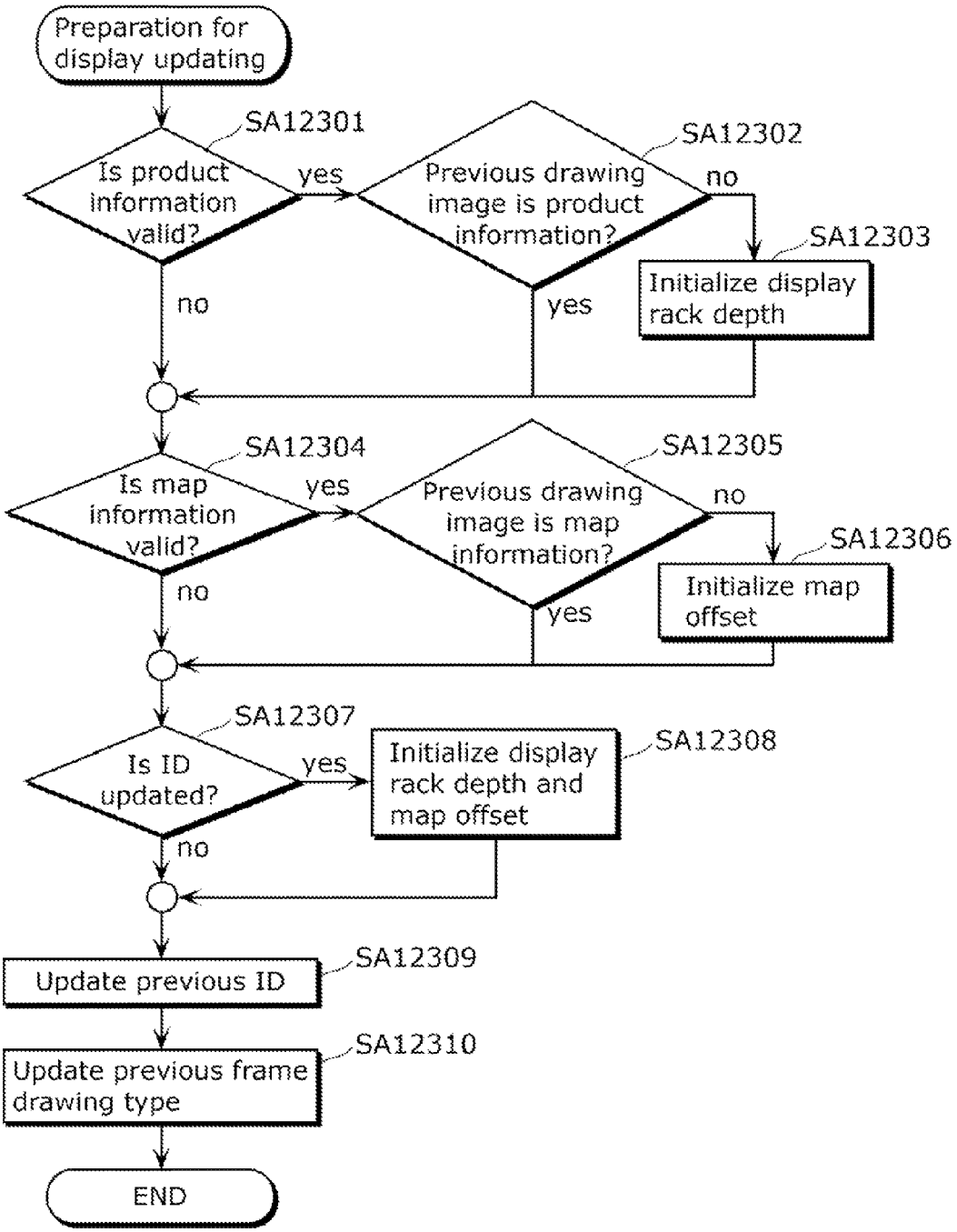

Preparation for display updating
SA12301
Is product information valid?
yes
SA12302
Previous drawing image is product information?
no
SA12303
Initialize display rack depth
no
yes
SA12304
Is map information valid?
yes
SA12305
Previous drawing image is map information?
no
SA12306
Initialize map offset
no
yes
SA12307
Is ID updated?
yes
SA12308
Initialize display rack depth and map offset
no
SA12309
Update previous ID
SA12310
Update previous frame drawing type
END

FIG. 24

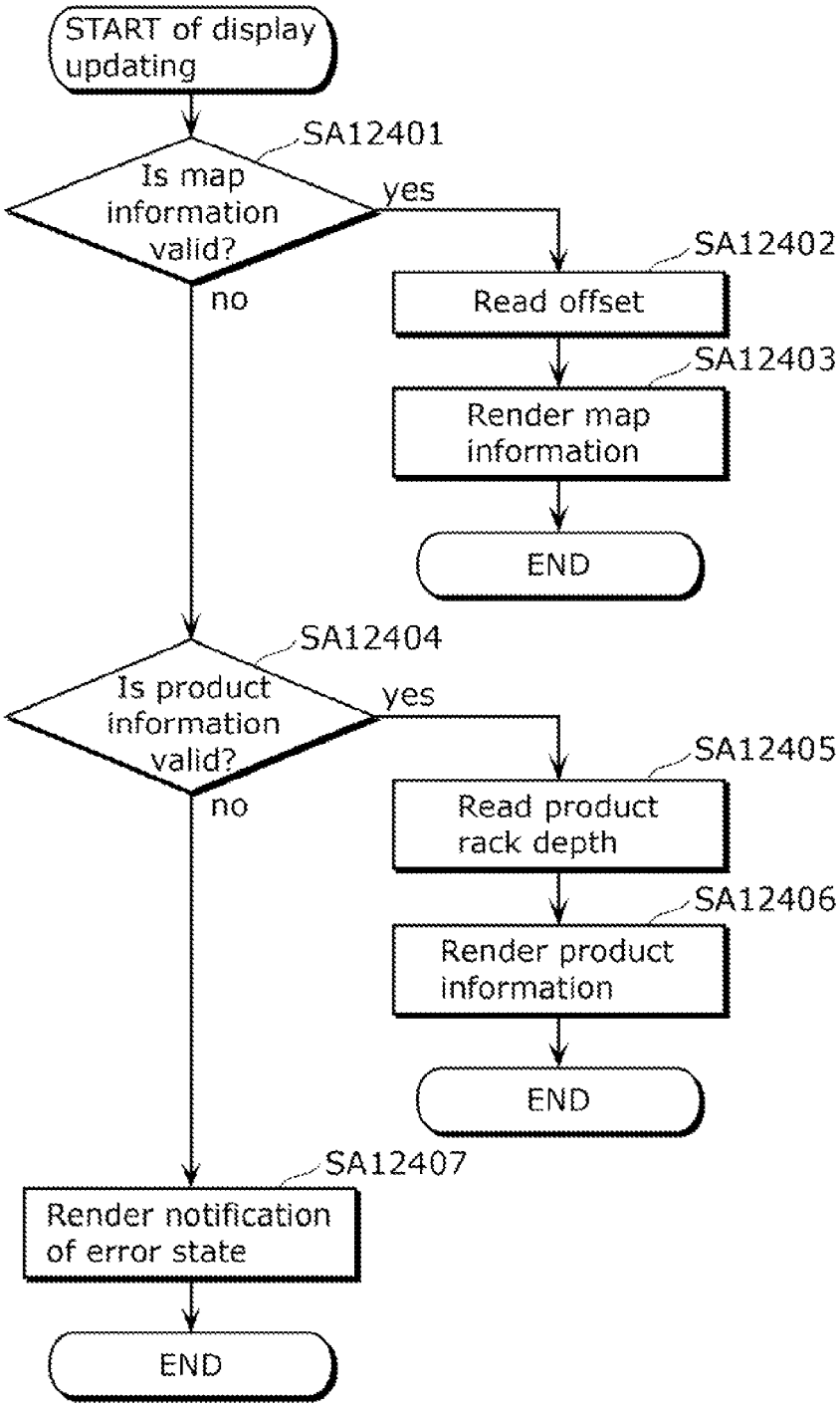

START of display updating
SA12401
Is map information valid?
yes
no
SA12402
Read offset
SA12403
Render map information
END
SA12404
Is product information valid?
yes
no
SA12405
Read product rack depth
SA12406
Render product information
END
SA12407
Render notification of error state
END

FIG. 25

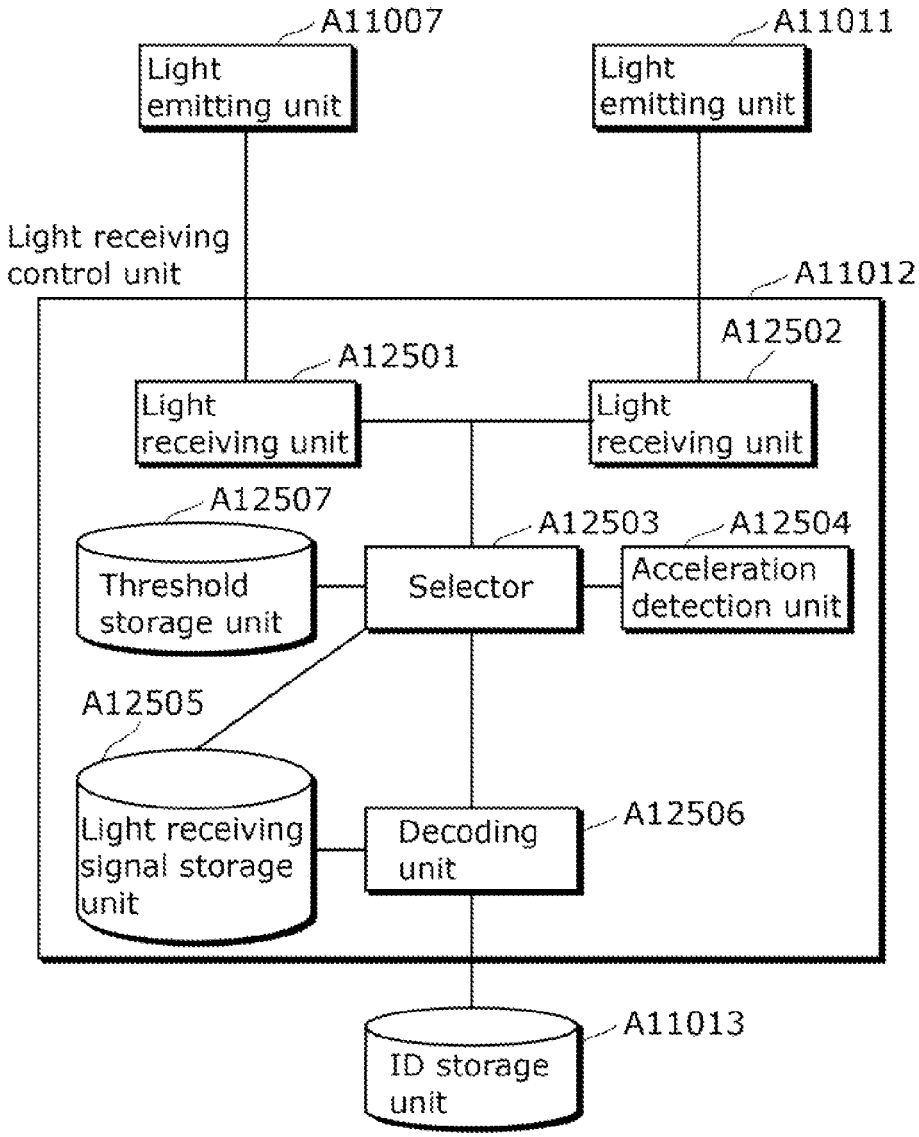

A11007
Light emitting unit
A11011
Light emitting unit
Light receiving control unit
A11012
A12502
A12501
Light receiving unit
Light receiving unit
A12507
A12503
A12504
Threshold storage unit
Selector
Acceleration detection unit
A12505
Light receiving signal storage unit
Decoding unit
A12506
A11013
ID storage unit

FIG. 26

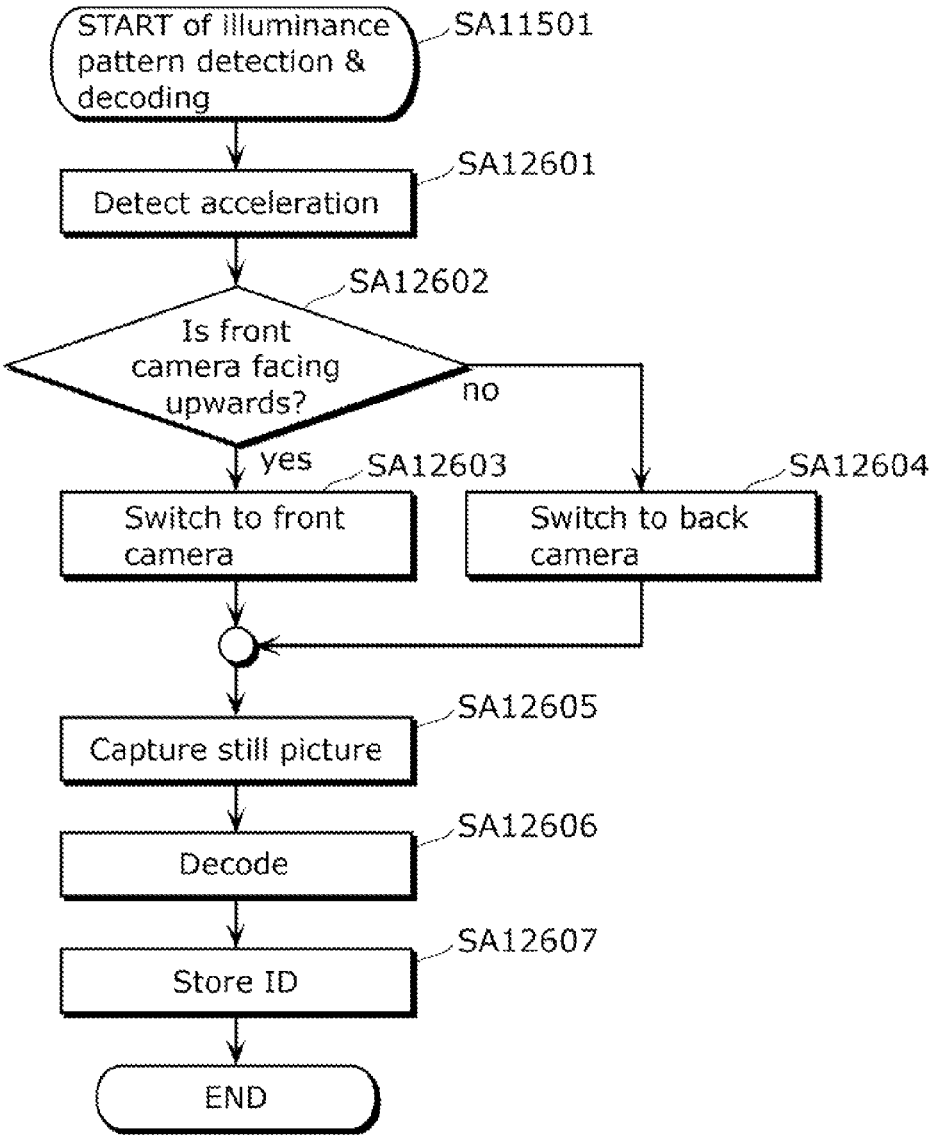

START of illuminance pattern detection & decoding
SA11501
Detect acceleration
SA12601
SA12602
Is front camera facing upwards?
no
yes
SA12603
SA12604
Switch to front camera
Switch to back camera
Capture still picture
SA12605
Decode
SA12606
Store ID
SA12607
END

FIG. 27

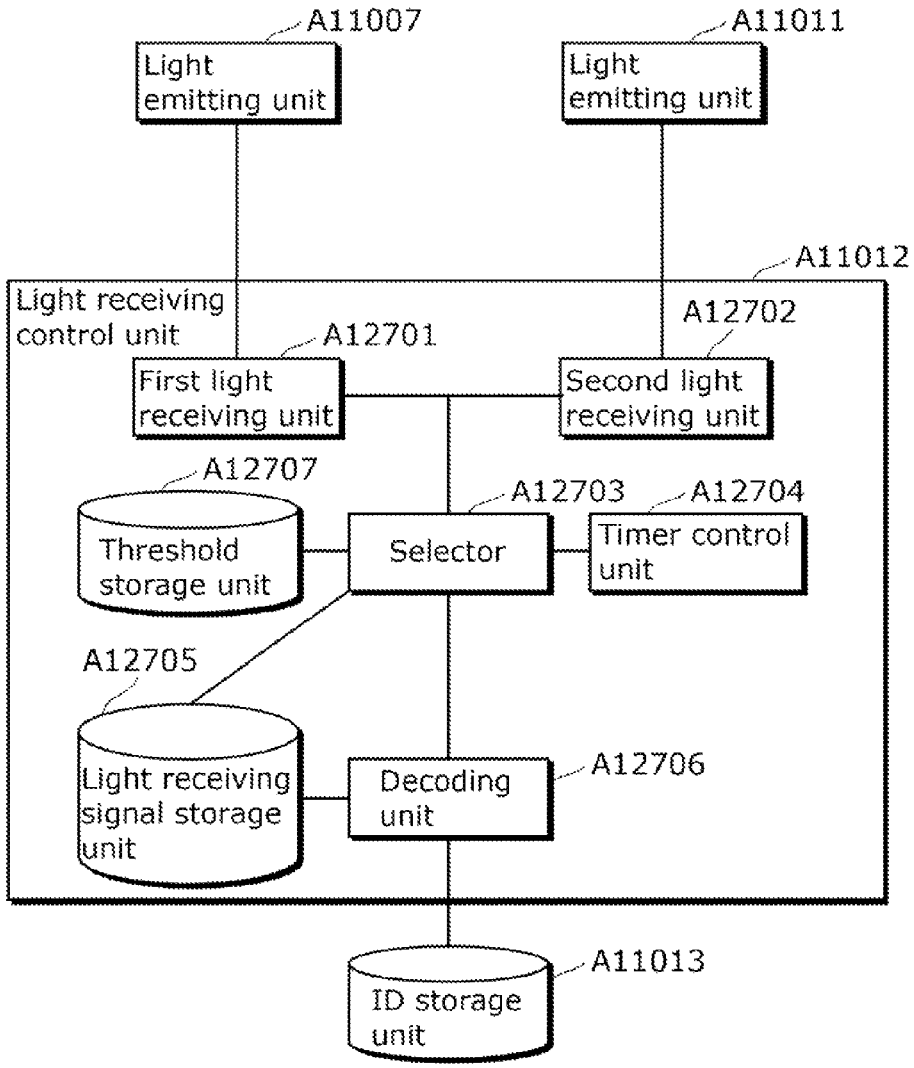

A11007
Light emitting unit
A11011
Light emitting unit
A11012
Light receiving control unit
A12701
First light receiving unit
A12702
Second light receiving unit
A12707
Threshold storage unit
A12703
Selector
A12704
Timer control unit
A12705
Light receiving signal storage unit
Decoding unit
A12706
ID storage unit
A11013

FIG. 28

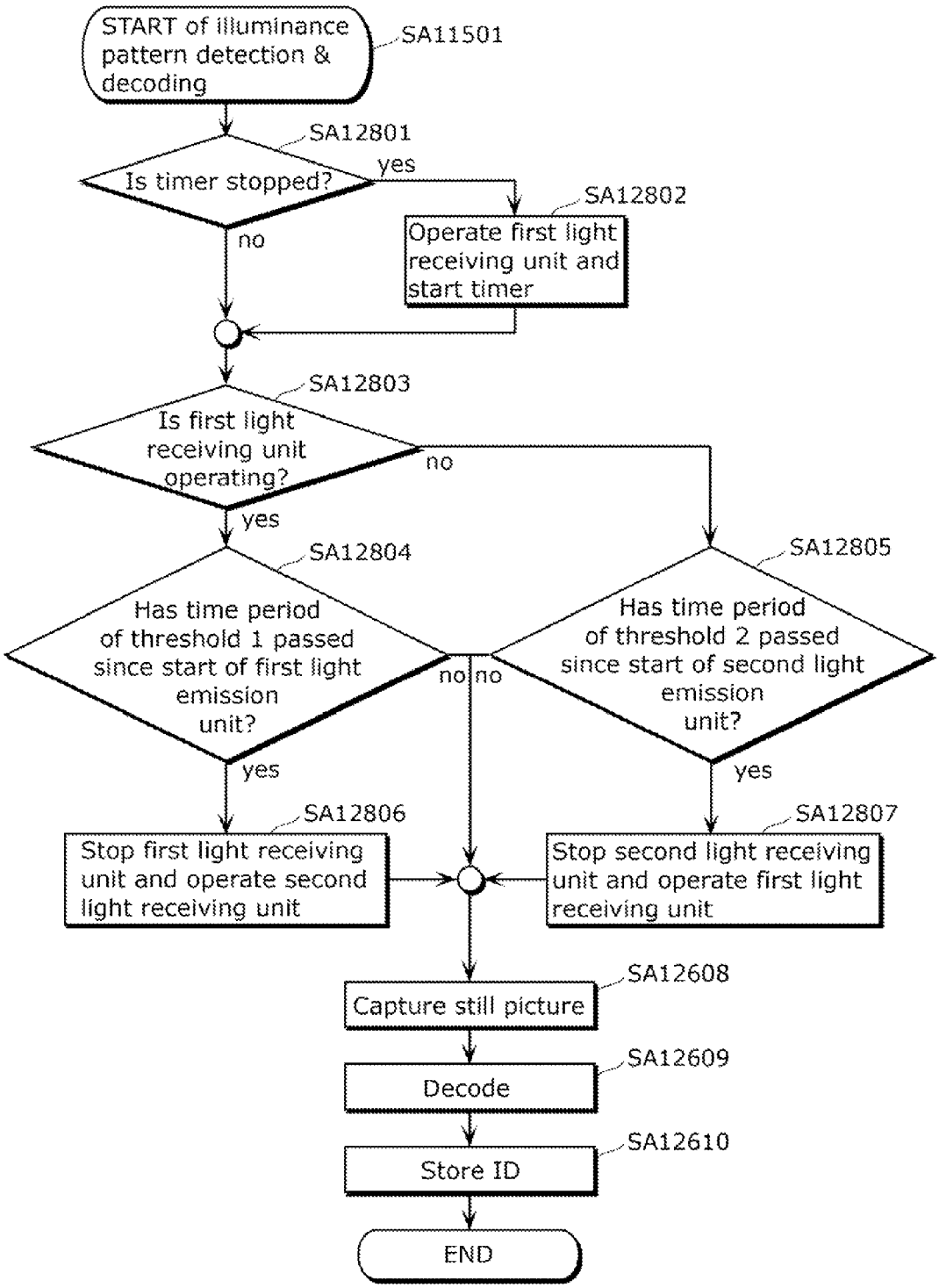

START of illuminance pattern detection & decoding
SA11501
SA12801
Is timer stopped?
yes
no
SA12802
Operate first light receiving unit and start timer
SA12803
Is first light receiving unit operating?
no
yes
SA12804
Has time period of threshold 1 passed since start of first light emission unit?
SA12805
Has time period of threshold 2 passed since start of second light emission unit?
no
no
yes
yes
SA12806
Stop first light receiving unit and operate second light receiving unit
SA12807
Stop second light receiving unit and operate first light receiving unit
SA12608
Capture still picture
SA12609
Decode
SA12610
Store ID
END

FIG. 29

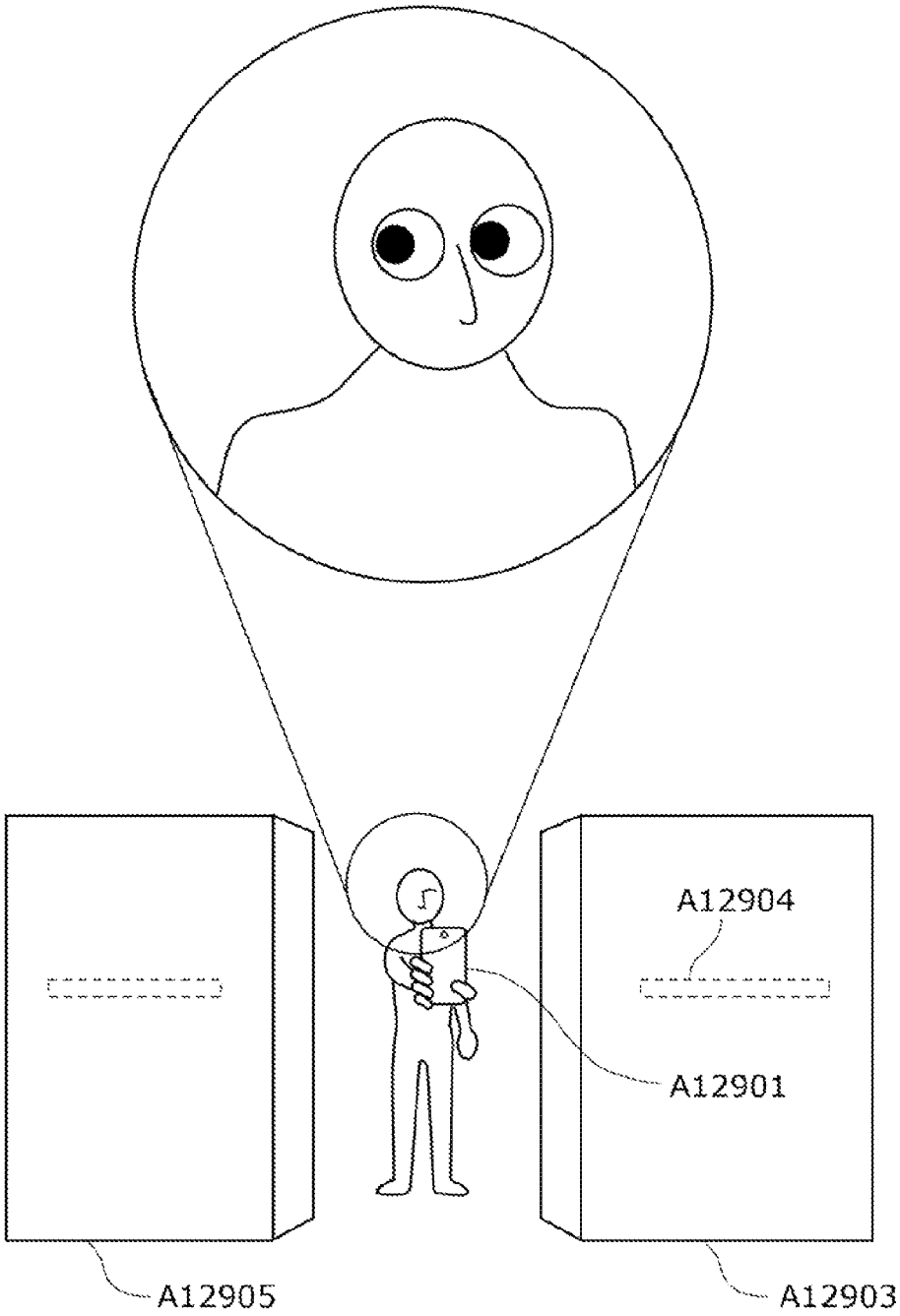


FIG. 30

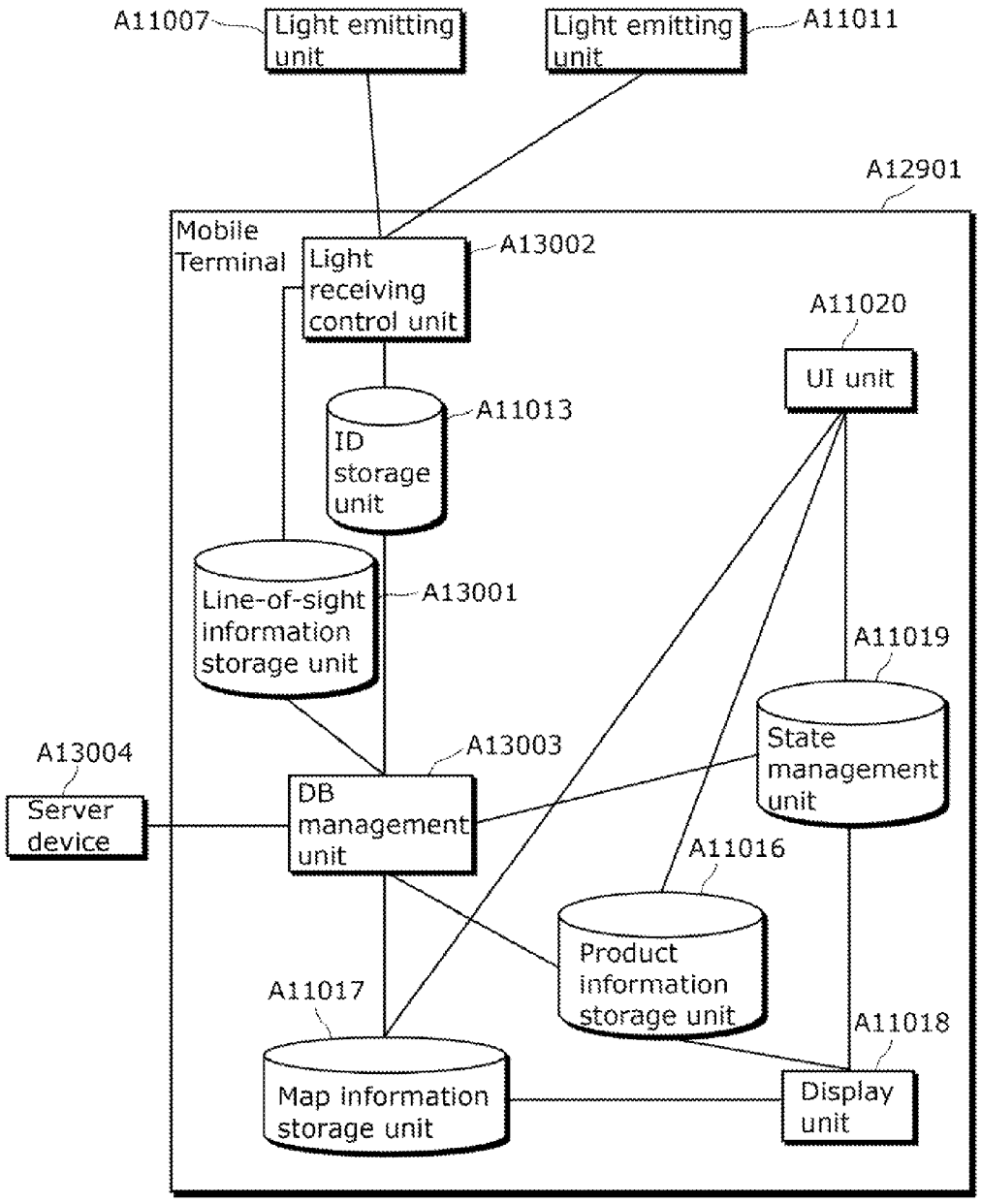

A11007
Light emitting unit
Light emitting unit
A11011
A12901
Mobile Terminal
Light receiving control unit
A13002
A11020
UI unit
ID storage unit
A11013
Line-of-sight information storage unit
A13001
A11019
State management unit
A13004
Server device
A13003
DB management unit
A11016
Product information storage unit
A11017
A11018
Map information storage unit
Display unit

FIG. 31

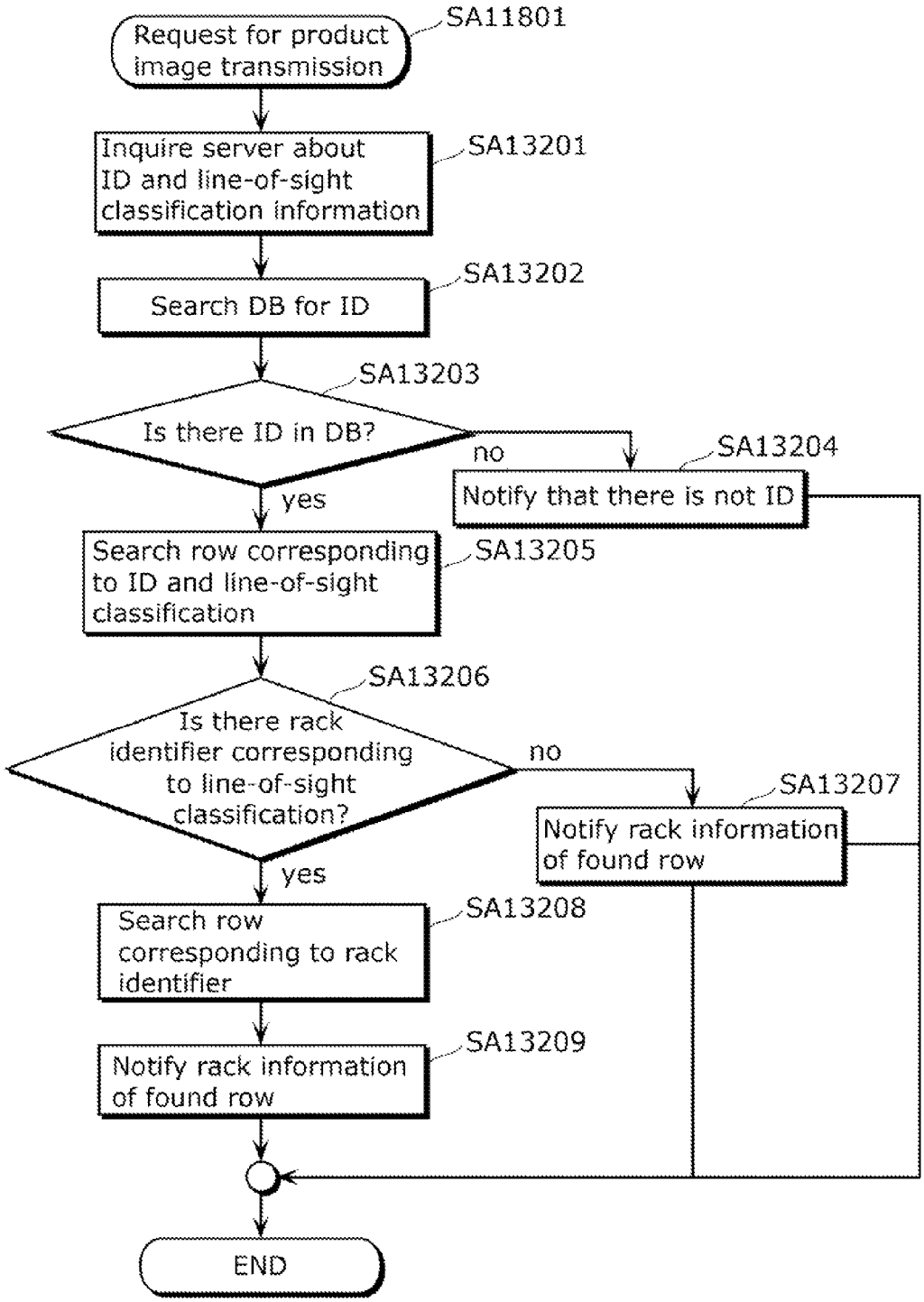

Request for product image transmission
SA11801
Inquire server about ID and line-of-sight classification information
SA13201
Search DB for ID
SA13202
Is there ID in DB?
SA13203
no
Notify that there is not ID
SA13204
yes
Search row corresponding to ID and line-of-sight classification
SA13205
Is there rack identifier corresponding to line-of-sight classification?
SA13206
no
Notify rack information of found row
SA13207
yes
Search row corresponding to rack identifier
SA13208
Notify rack information of found row
SA13209
END

FIG. 32

A13101 Rack identifier	A13102 Illumination ID	A13103 Rack identifier of left rack	A13104 Rack identifier of right rack	A13105 Rack information
100	200	–	101	(Rack information 1)
101	201	100	102	(Rack information 2)
102	–	101	103	(Rack information 3)
103	202	102	–	(Rack information 4)

FIG. 33

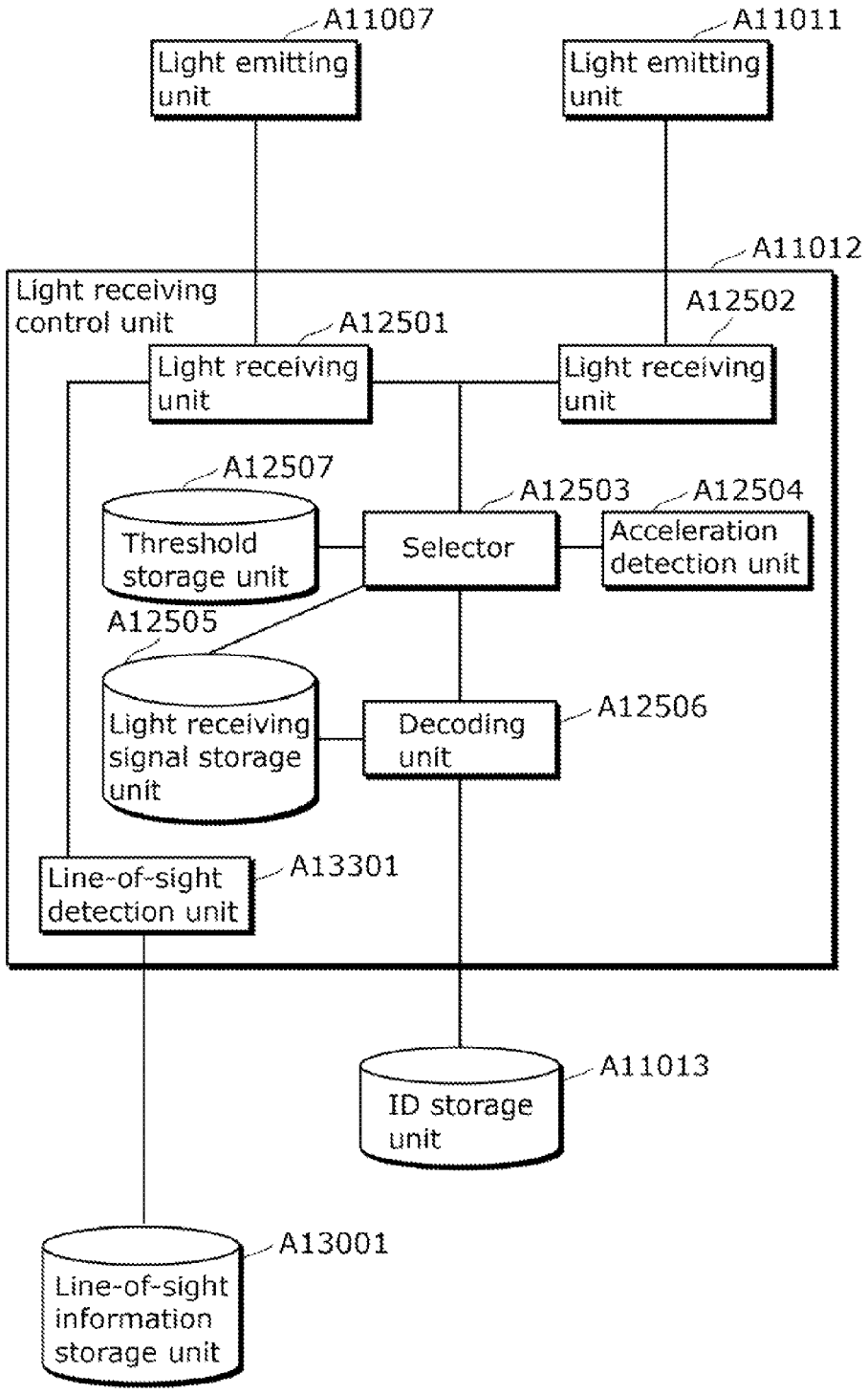

A11007
Light emitting unit
A11011
Light emitting unit
A11012
Light receiving control unit
A12501
Light receiving unit
A12502
Light receiving unit
A12507
Threshold storage unit
A12503
Selector
A12504
Acceleration detection unit
A12505
Light receiving signal storage unit
Decoding unit
A12506
Line-of-sight detection unit
A13301
A11013
ID storage unit
A13001
Line-of-sight information storage unit

FIG. 34

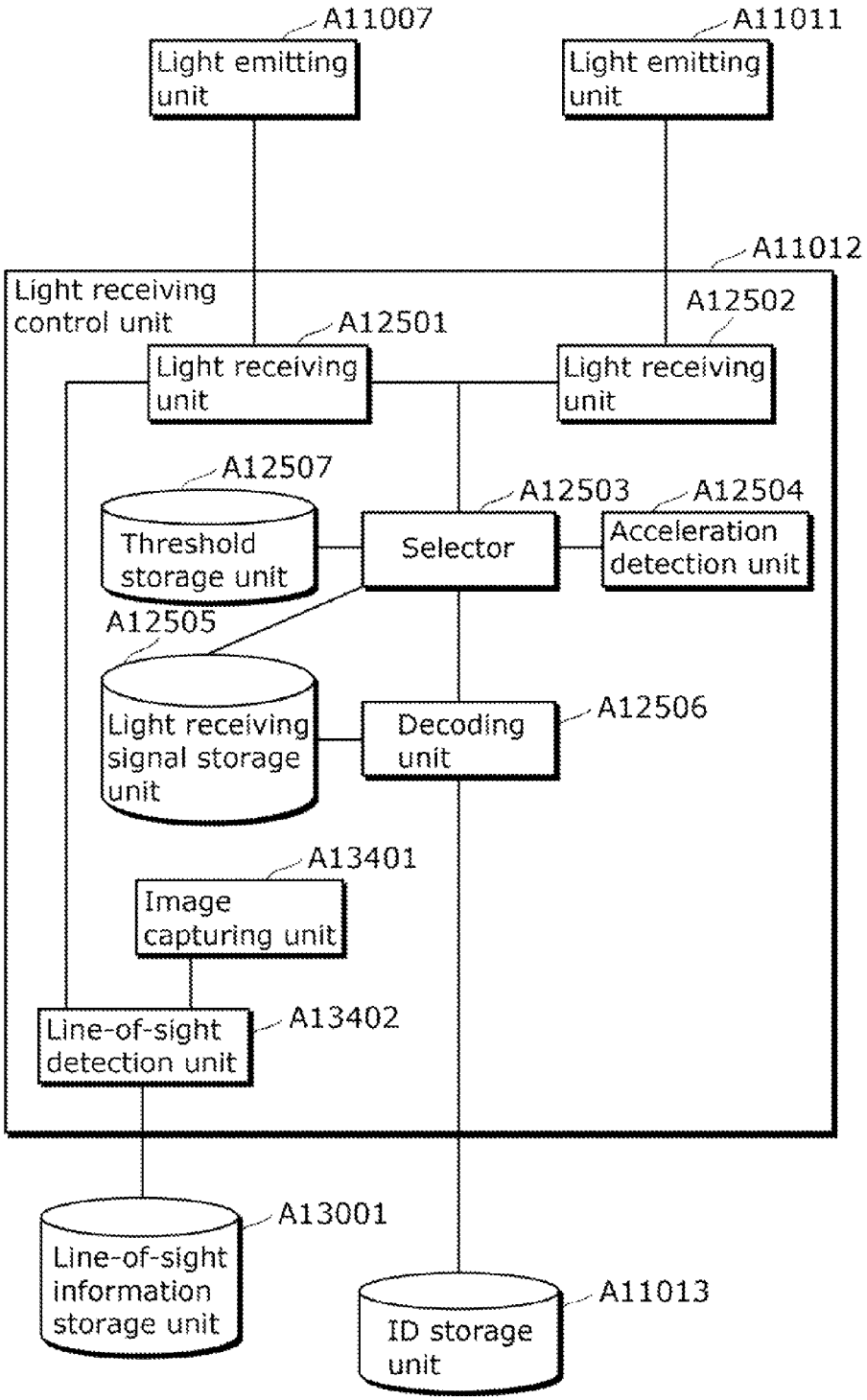

A11007
Light emitting unit
A11011
Light emitting unit
A11012
Light receiving control unit
A12501
Light receiving unit
A12502
Light receiving unit
A12507
Threshold storage unit
A12503
Selector
A12504
Acceleration detection unit
A12505
Light receiving signal storage unit
Decoding unit
A12506
A13401
Image capturing unit
Line-of-sight detection unit
A13402
A13001
Line-of-sight information storage unit
ID storage unit
A11013

FIG. 35

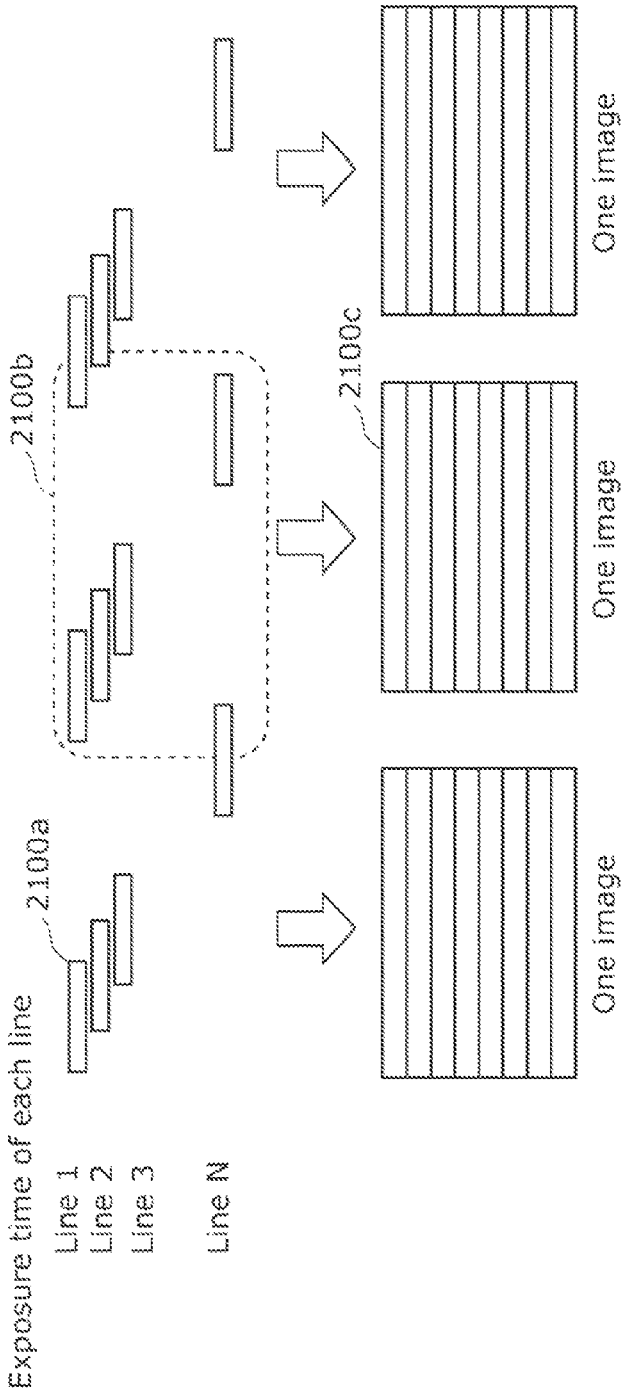

time
Exposure time of each line
Line 1
Line 2
Line 3
Line N
2100a
2100b
2100c
One image
One image
One image

FIG. 36

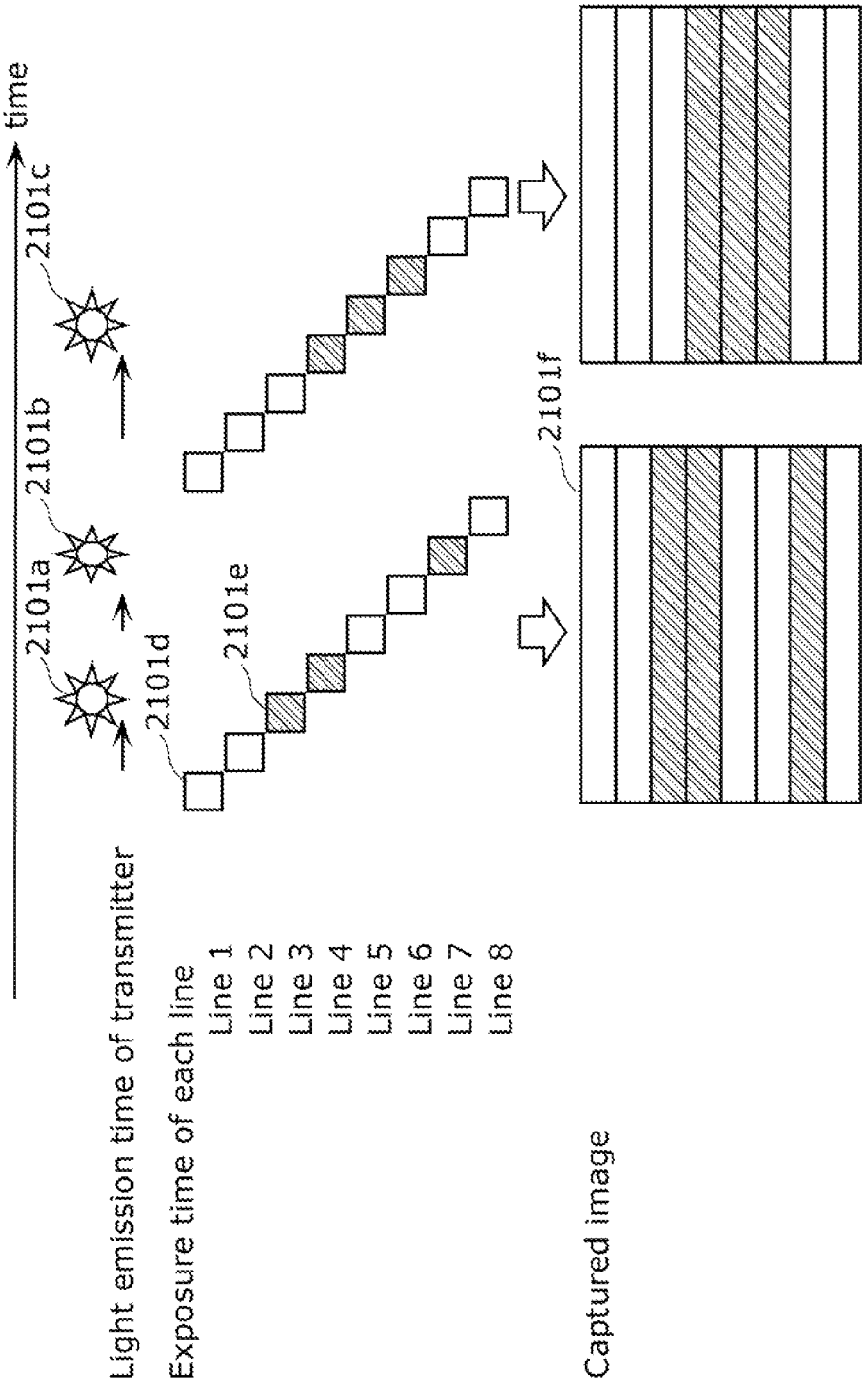

time
2101a
2101b
2101c
2101d
2101e
2101f
Light emission time of transmitter
Exposure time of each line
Line 1
Line 2
Line 3
Line 4
Line 5
Line 6
Line 7
Line 8
Captured image

FIG. 37

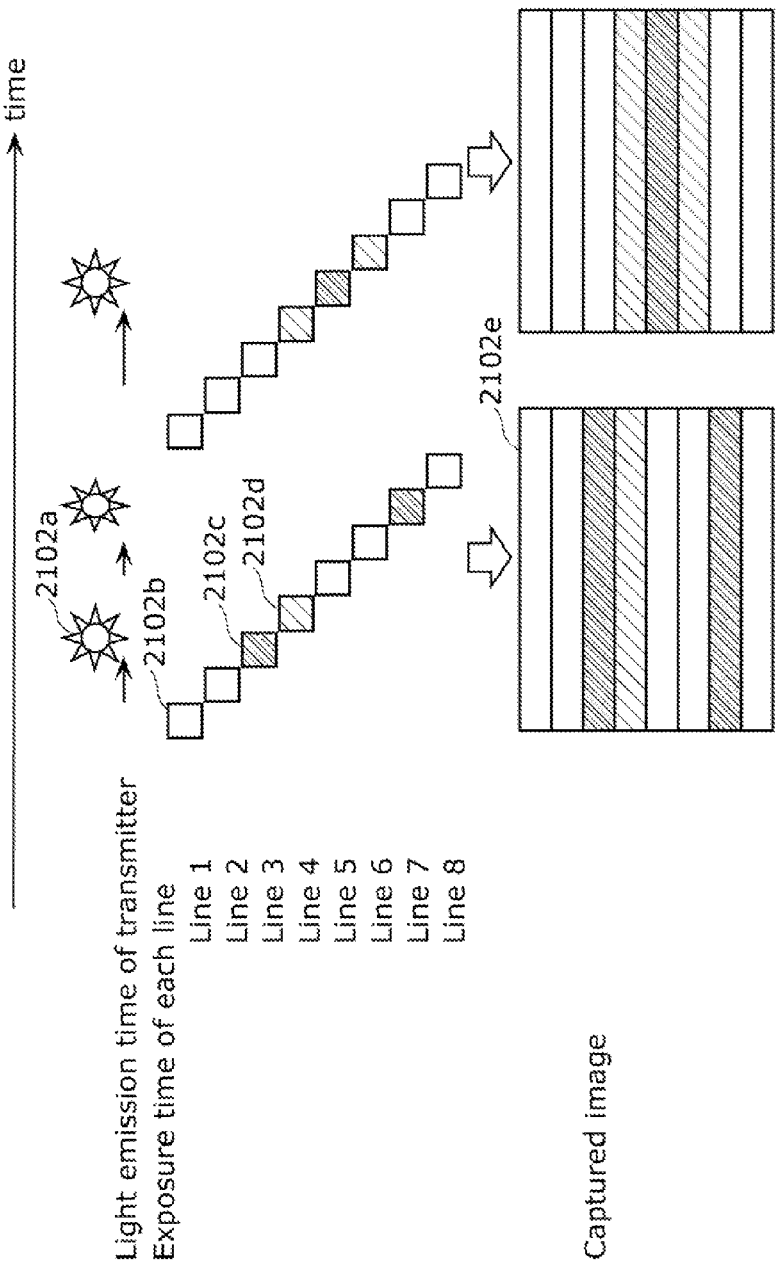

time
2102a
2102b
2102c
2102d
2102e
Light emission time of transmitter
Exposure time of each line
Line 1
Line 2
Line 3
Line 4
Line 5
Line 6
Line 7
Line 8
Captured image

FIG. 38

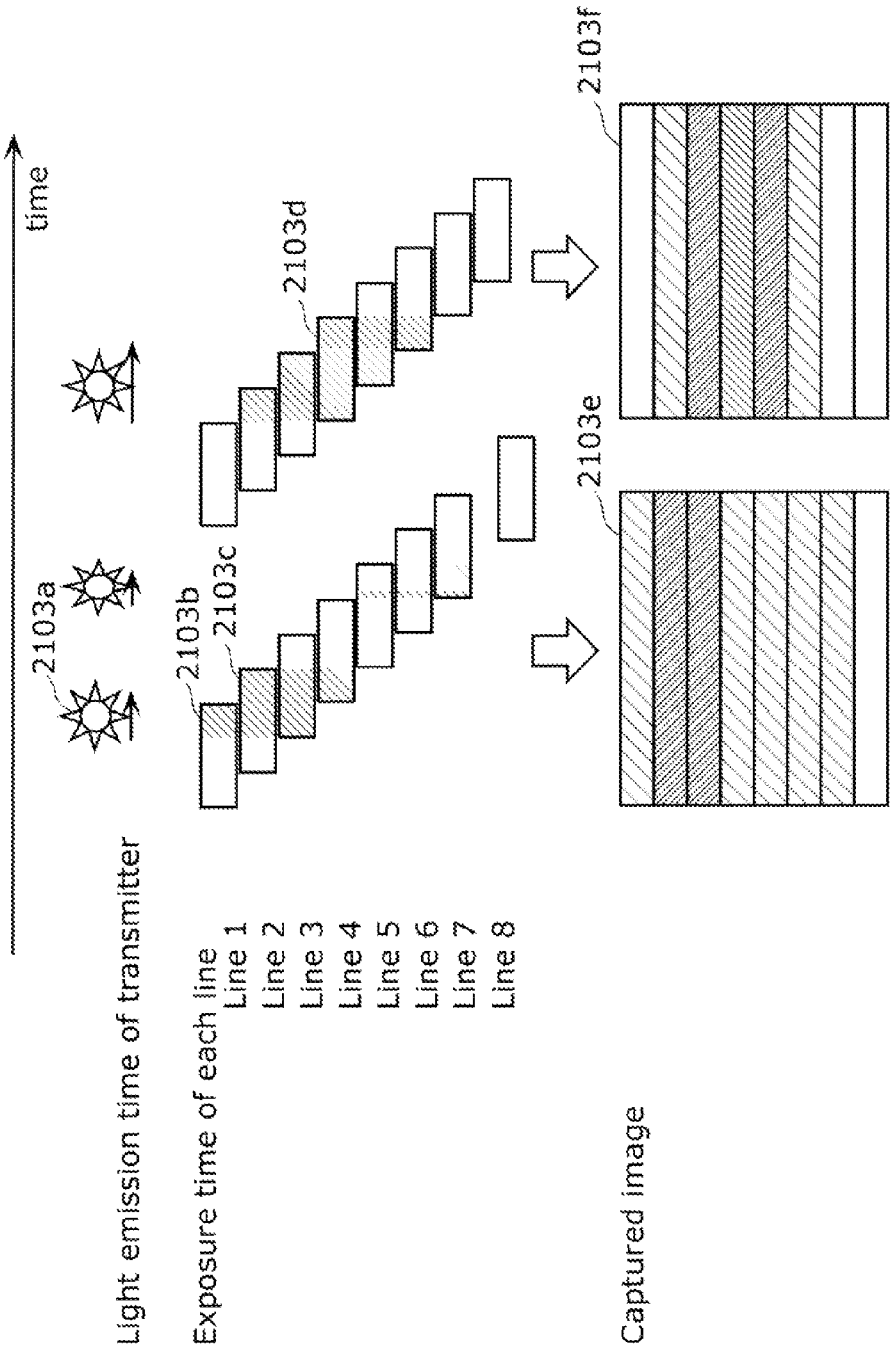

time
2103a
2103b
2103c
2103d
2103e
2103f
Light emission time of transmitter
Exposure time of each line
Line 1
Line 2
Line 3
Line 4
Line 5
Line 6
Line 7
Line 8
Captured image

FIG. 39

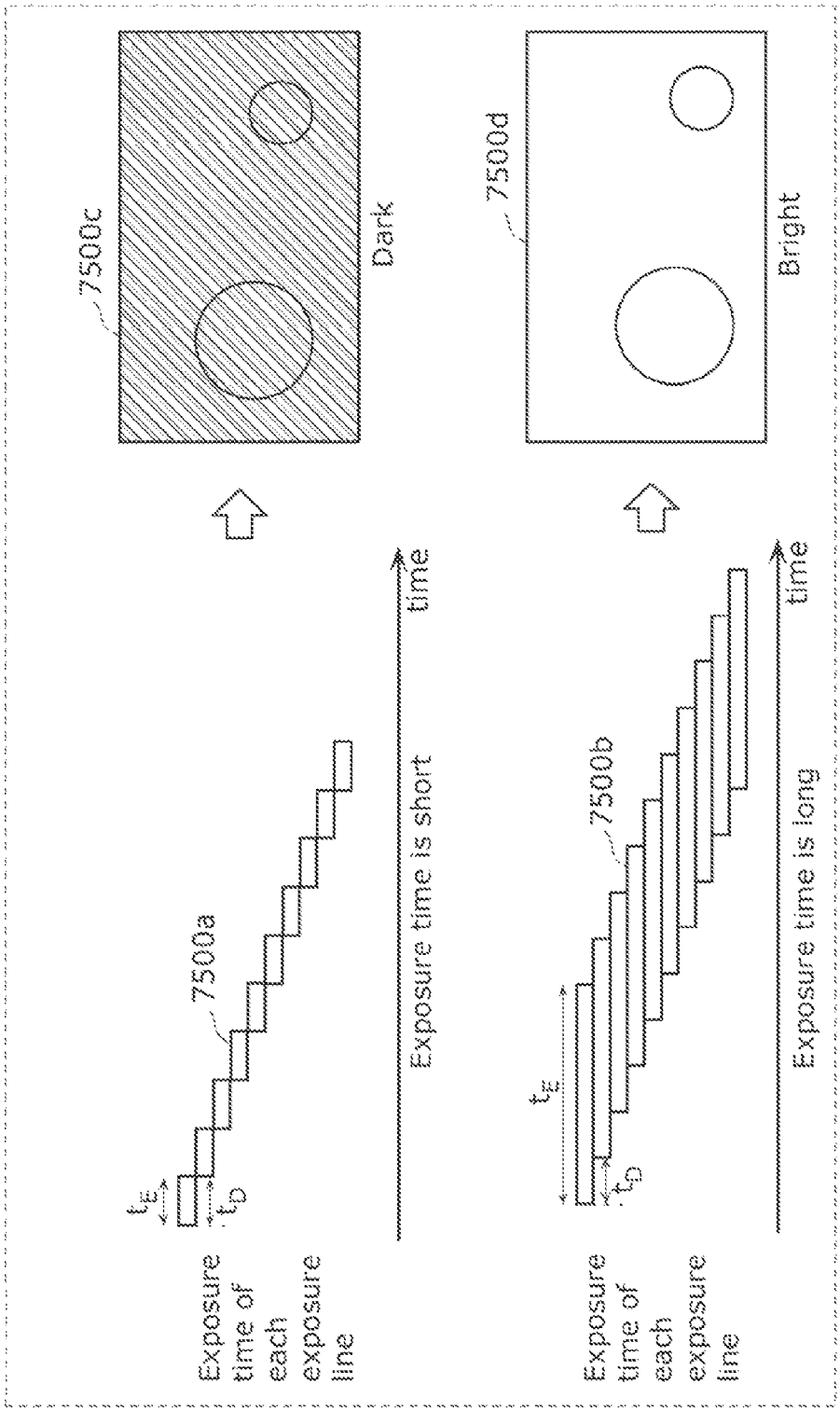

7500c
Dark
7500d
Bright
7500a
Exposure time is short
time
Exposure time of each exposure line
t_E
t_D
7500b
Exposure time is long
time
Exposure time of each exposure line
t_E
t_D

FIG. 40

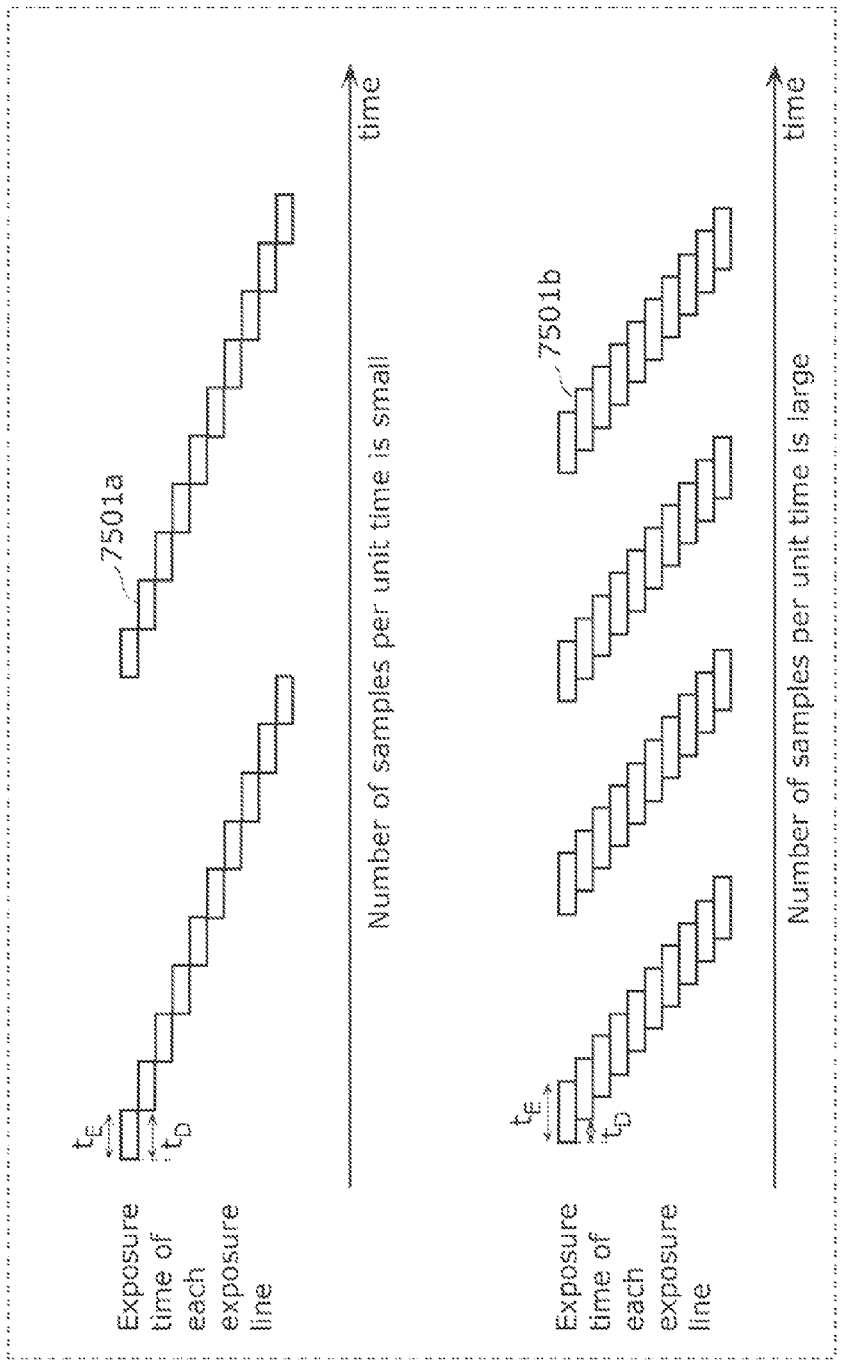

Exposure time of each exposure line
t_E
t_D
7501a
Number of samples per unit time is small
time
Exposure time of each exposure line
t_E
t_D
7501b
Number of samples per unit time is large
time

FIG. 41

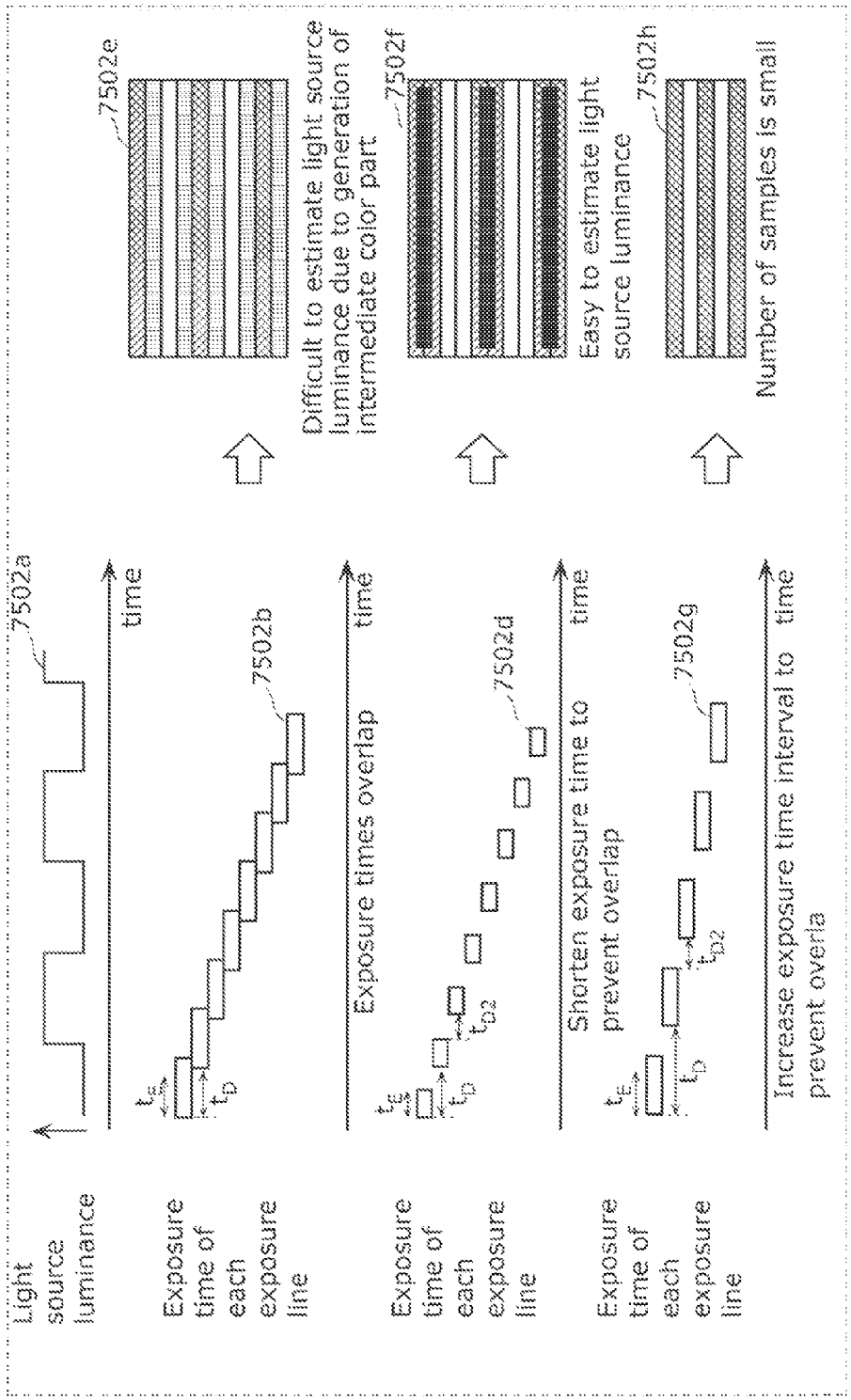

Light source luminance
7502a
time
Exposure time of each exposure line
7502b
Exposure times overlap
7502d
Shorten exposure time to prevent overlap
7502g
Increase exposure time interval to prevent overla
7502e
Difficult to estimate light source luminance due to generation of intermediate color part
7502f
Easy to estimate light source luminance
7502h
Number of samples is small

FIG. 42

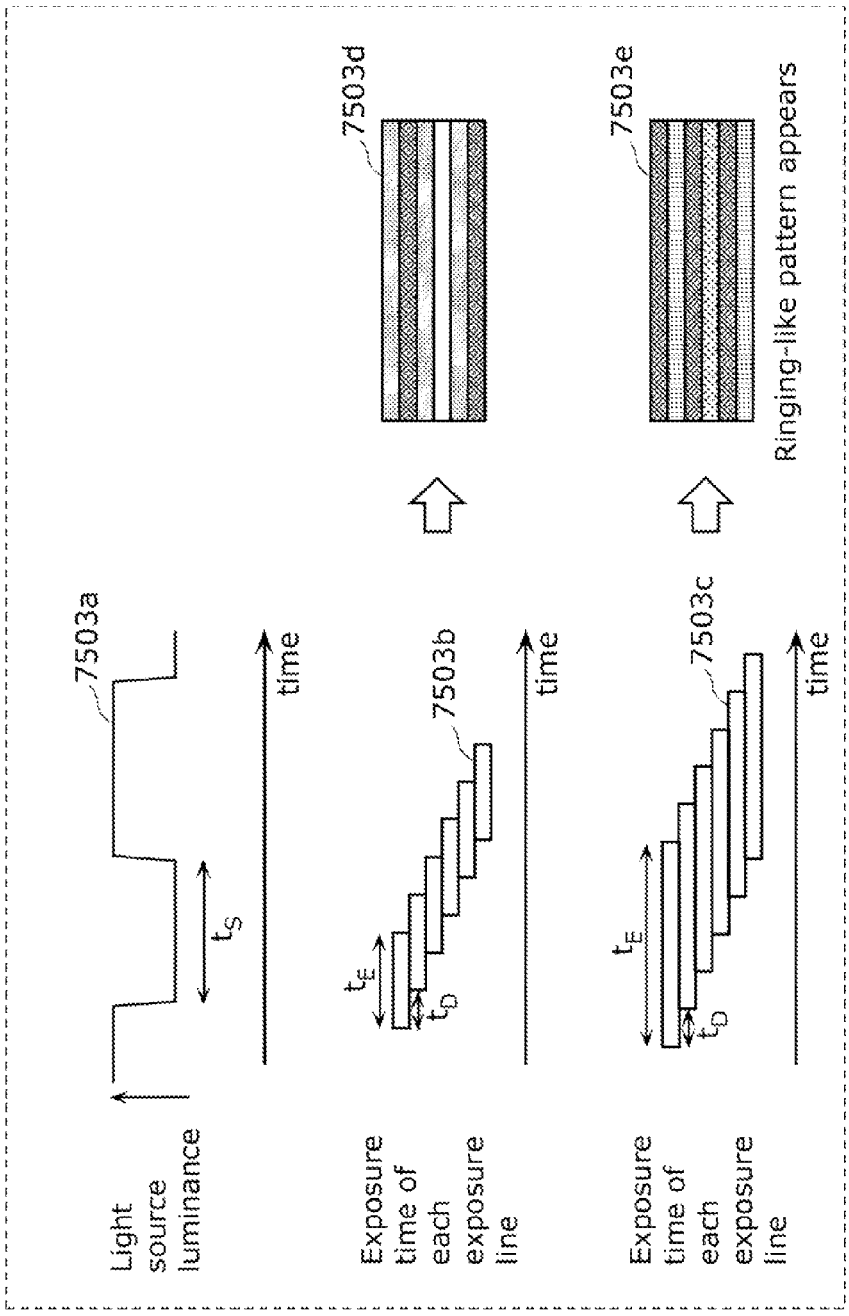

Light source luminance
7503a
time
t_S
Exposure time of each exposure line
7503b
time
t_E
t_D
7503d
Exposure time of each exposure line
7503c
time
t_E
t_D
7503e
Ringing-like pattern appears

FIG. 43

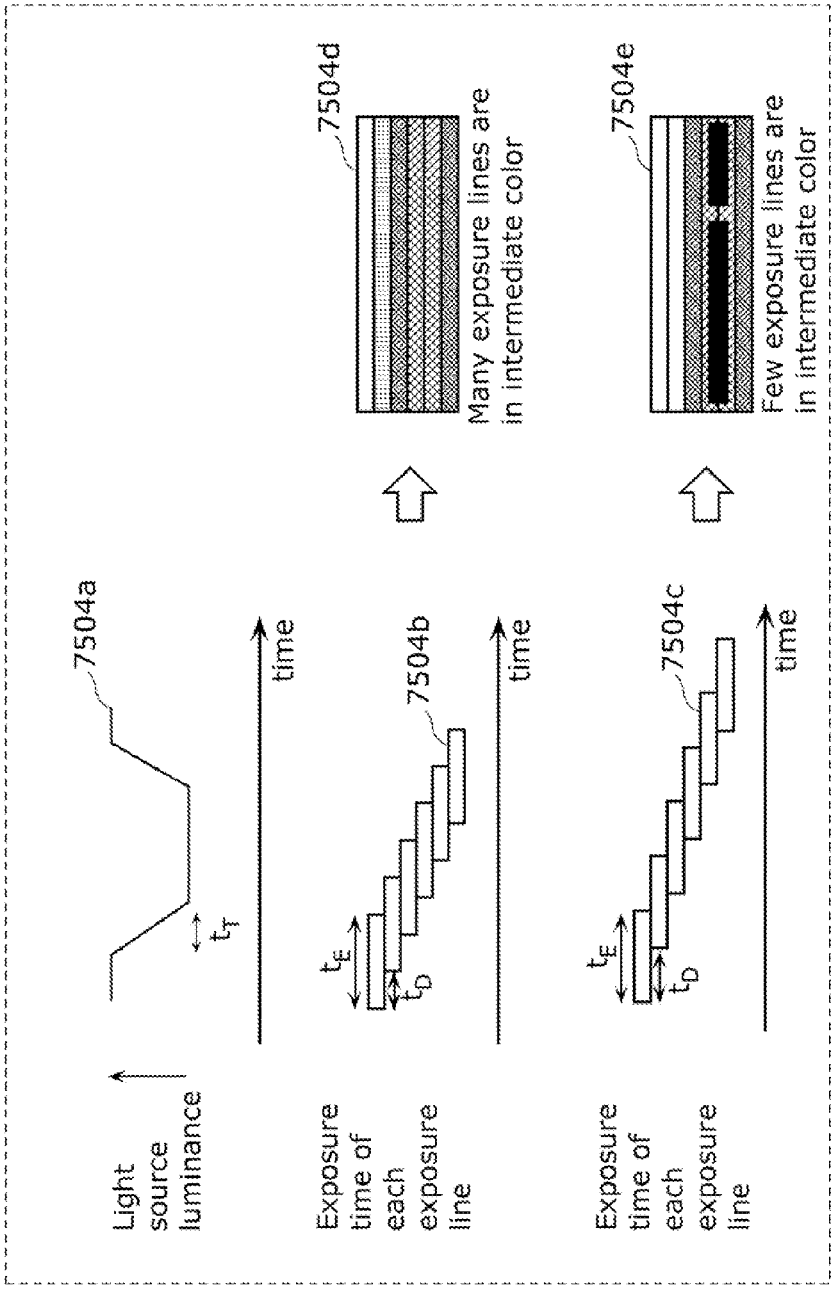

7504a
time
t_T
Light source luminance
7504b
time
t_E
t_D
Exposure time of each exposure line
7504c
time
t_E
t_D
Exposure time of each exposure line
7504d
Many exposure lines are in intermediate color
7504e
Few exposure lines are in intermediate color

FIG. 44

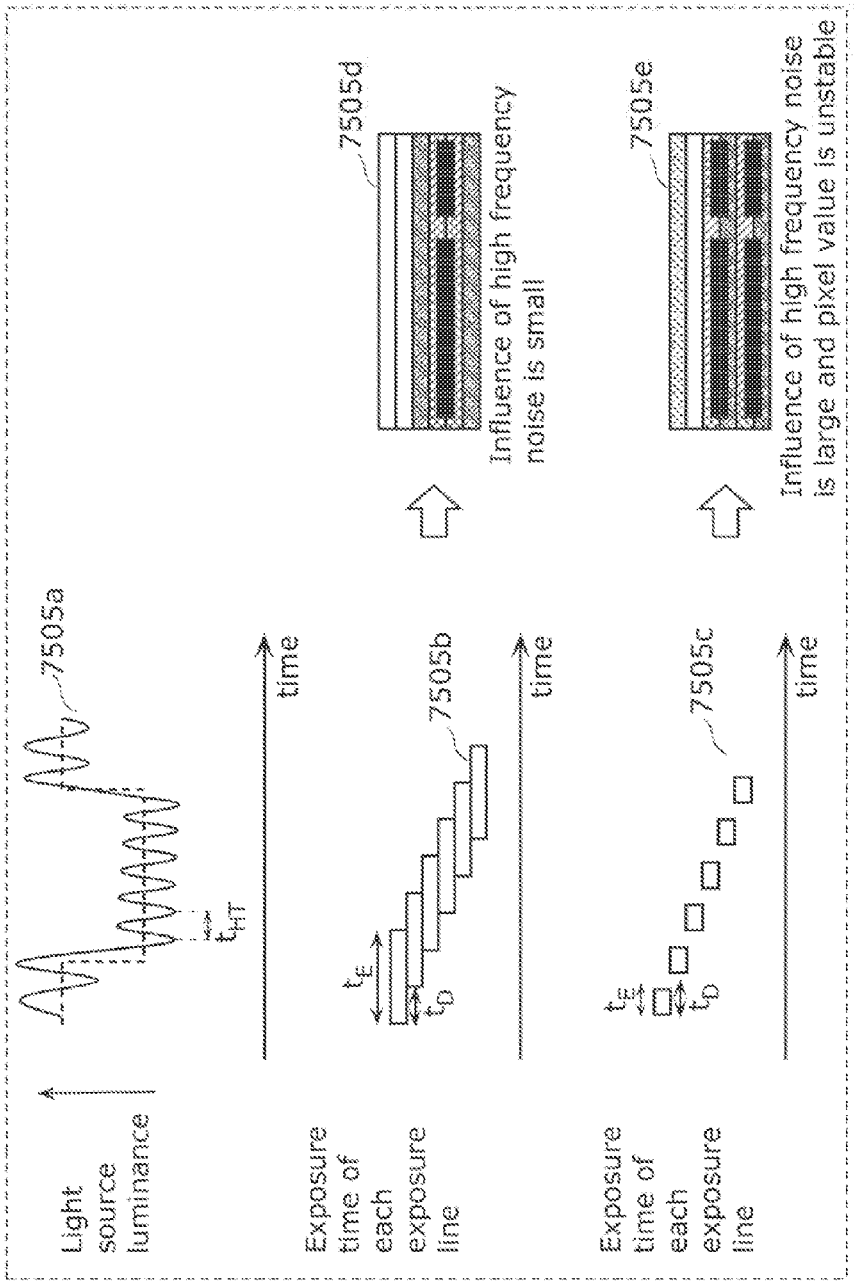

Light source luminance
7505a
t_{HT}
time
Exposure time of each exposure line
7505b
t_E
t_D
time
7505d
Influence of high frequency noise is small
Exposure time of each exposure line
7505c
t_E
t_D
time
7505e
Influence of high frequency noise is large and pixel value is unstable

FIG. 45

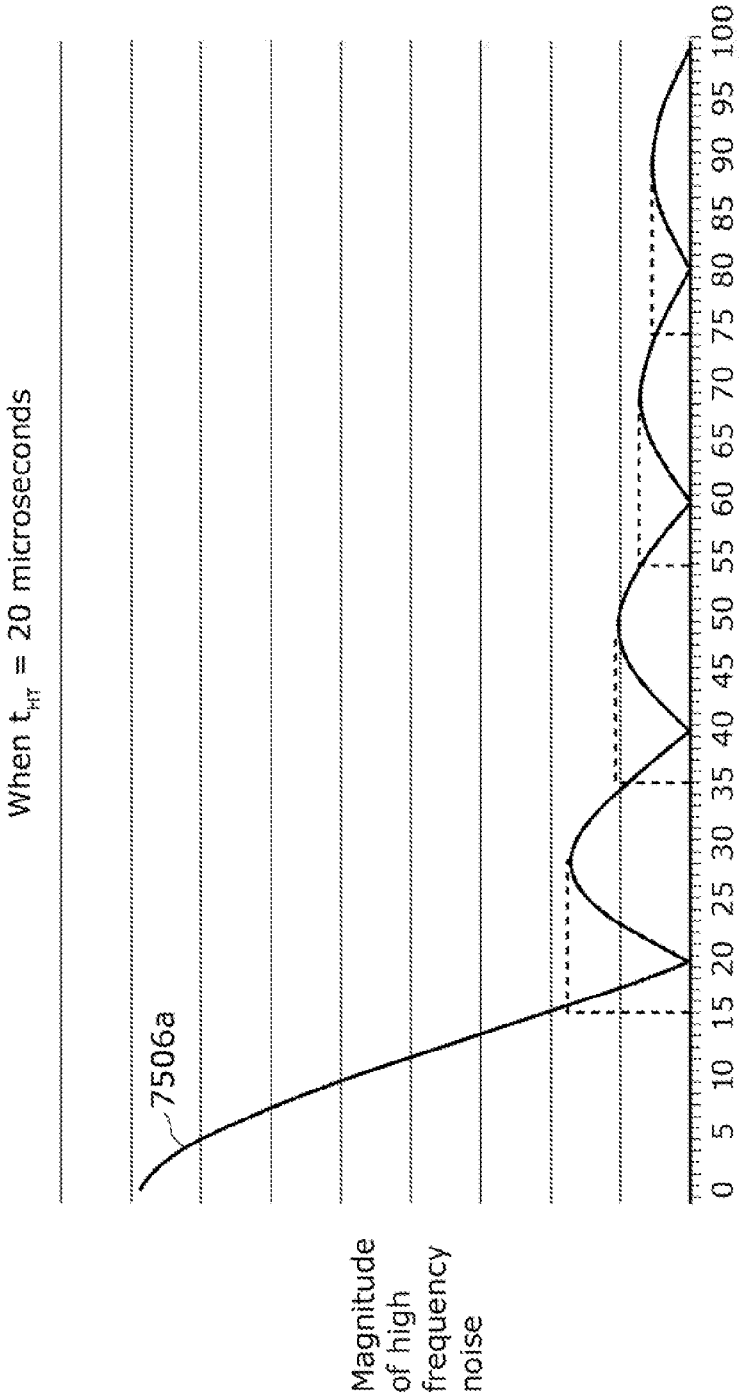

When t_{HT} = 20 microseconds
7506a
Magnitude of high frequency noise
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
t_E [microseconds]

FIG. 46

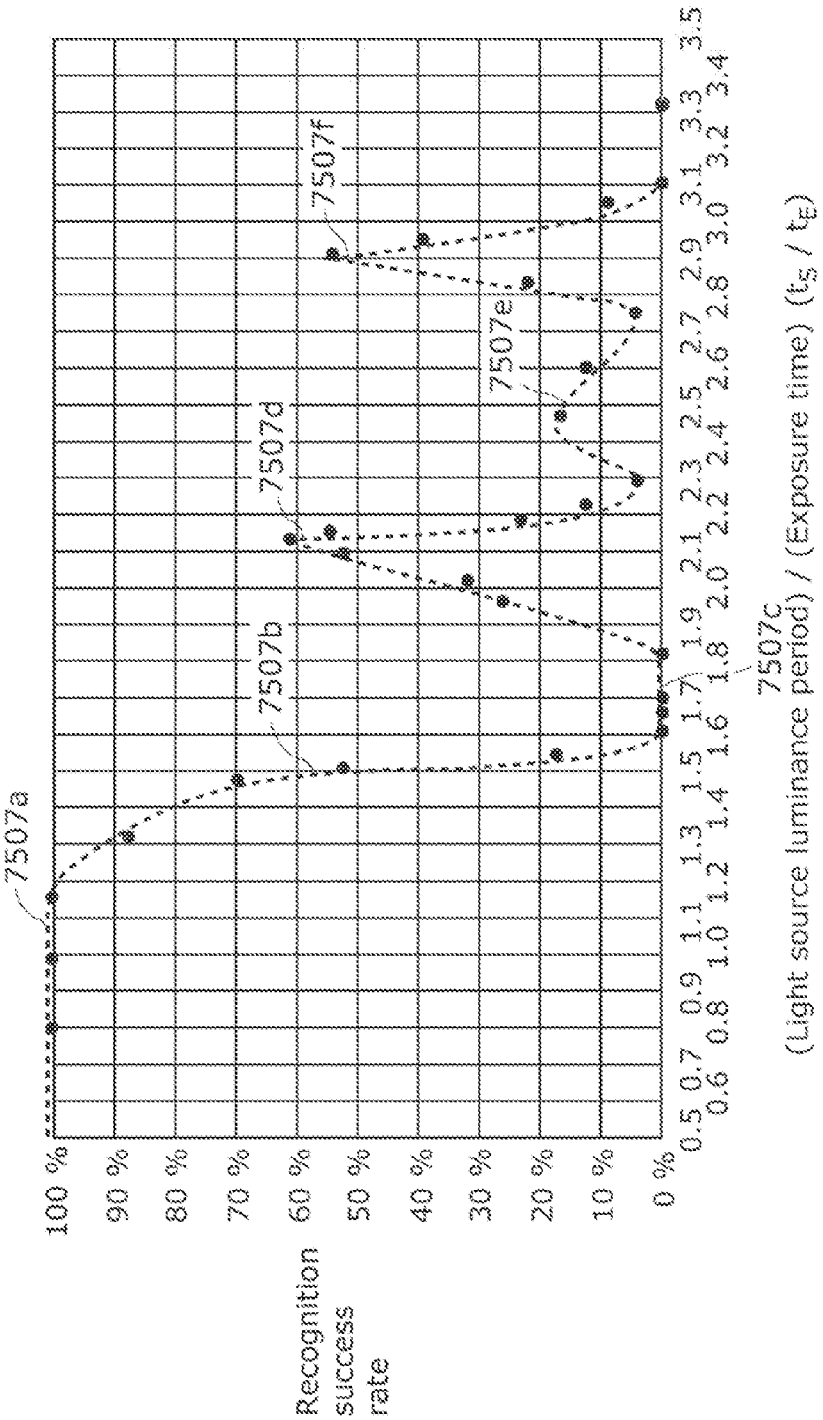

Recognition success rate
100 %
90 %
80 %
70 %
60 %
50 %
40 %
30 %
20 %
10 %
0 %
0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5
(Light source luminance period) / (Exposure time) (t_S / t_E)
7507a
7507b
7507c
7507d
7507e
7507f

FIG. 47

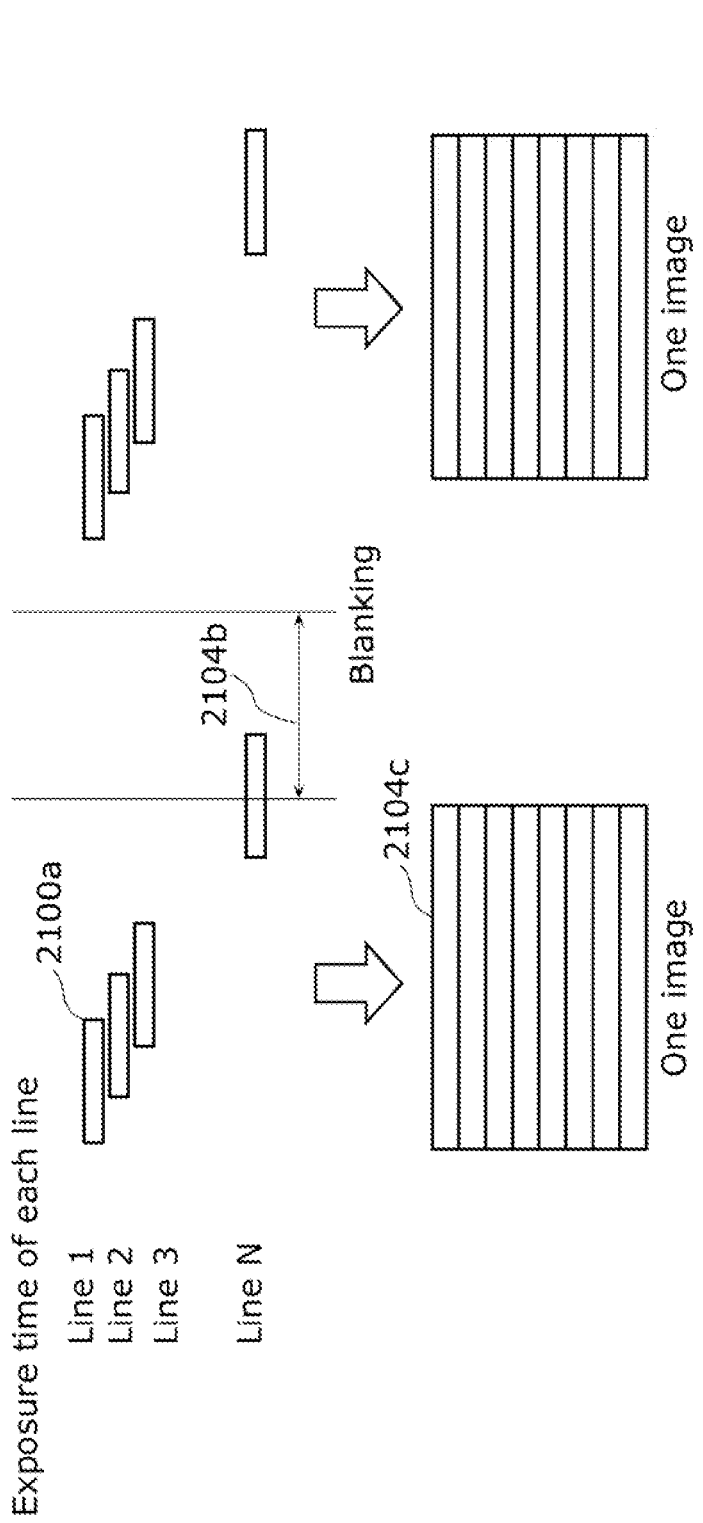

time
Exposure time of each line
Line 1
Line 2
Line 3
Line N
2100a
2104b
Blanking
2104c
One image
One image

FIG. 48

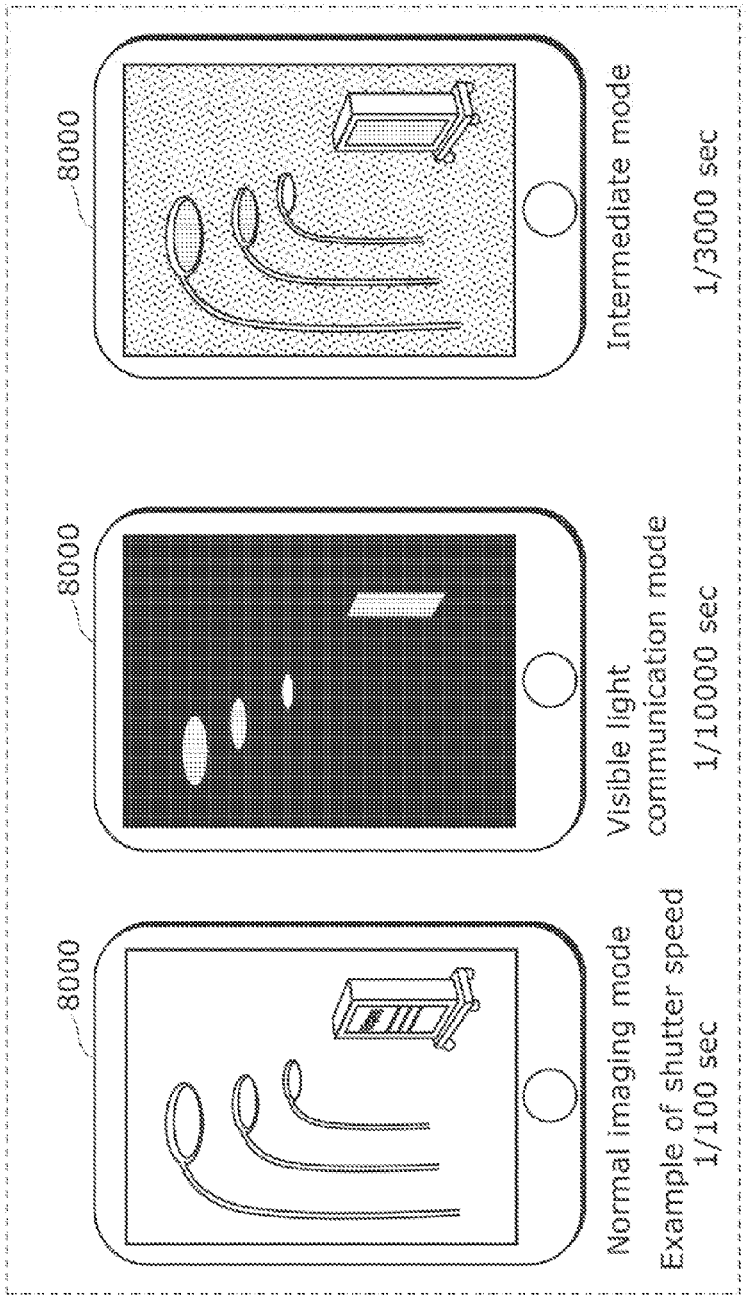

8000
Normal imaging mode
Example of shutter speed
1/100 sec
8000
Visible light
communication mode
1/10000 sec
8000
Intermediate mode
1/3000 sec

FIG. 49

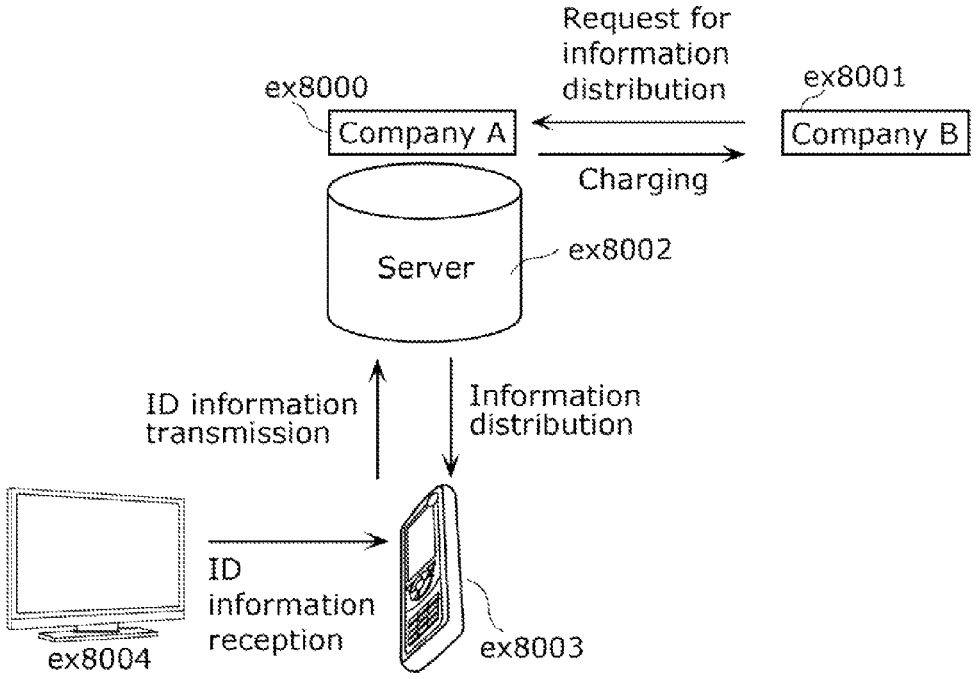

Request for information distribution
ex8000
ex8001
Company A
Company B
Charging
Server
ex8002
ID information transmission
Information distribution
ID information reception
ex8004
ex8003

FIG. 50

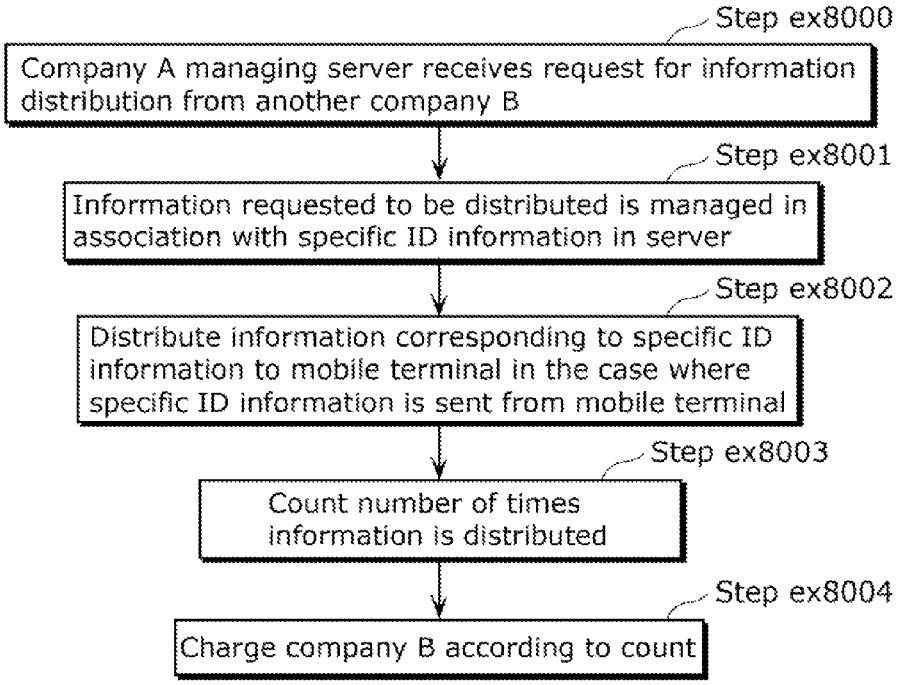

Step ex8000
Company A managing server receives request for information distribution from another company B
Step ex8001
Information requested to be distributed is managed in association with specific ID information in server
Step ex8002
Distribute information corresponding to specific ID information to mobile terminal in the case where specific ID information is sent from mobile terminal
Step ex8003
Count number of times information is distributed
Step ex8004
Charge company B according to count

FIG. 51

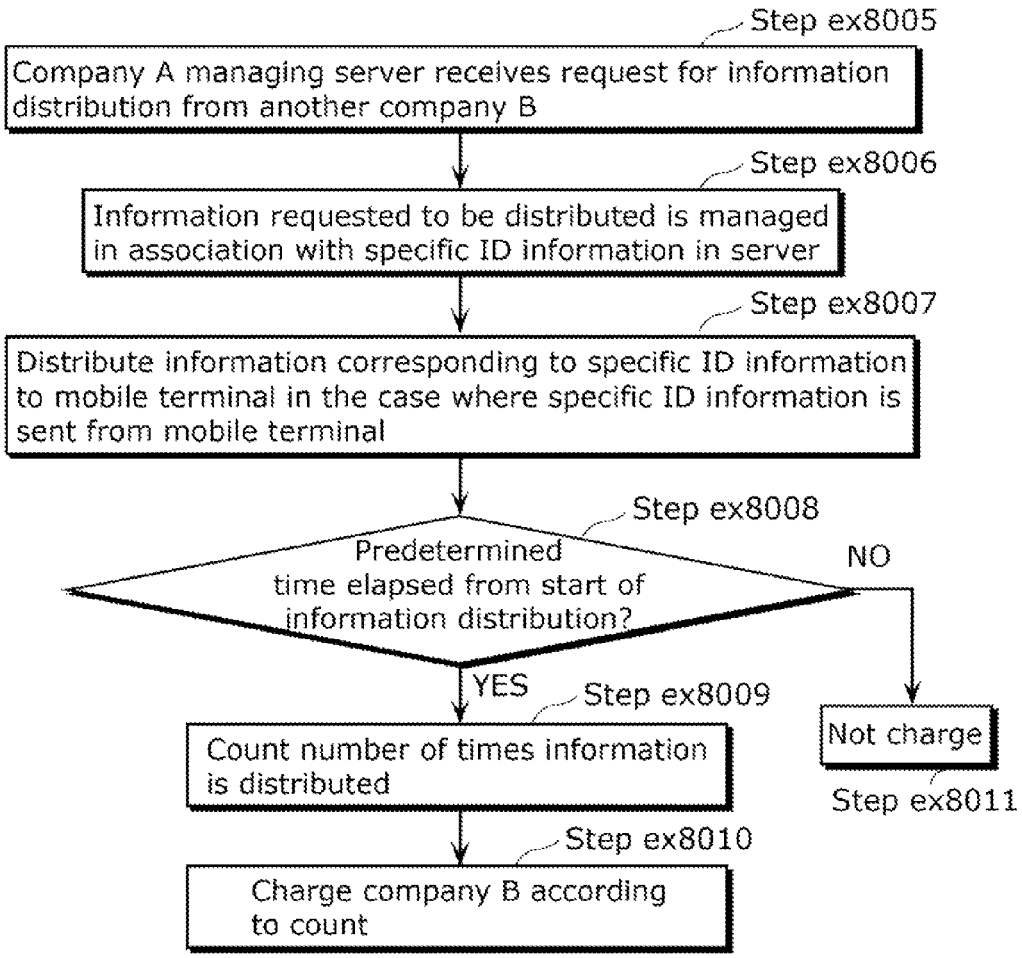
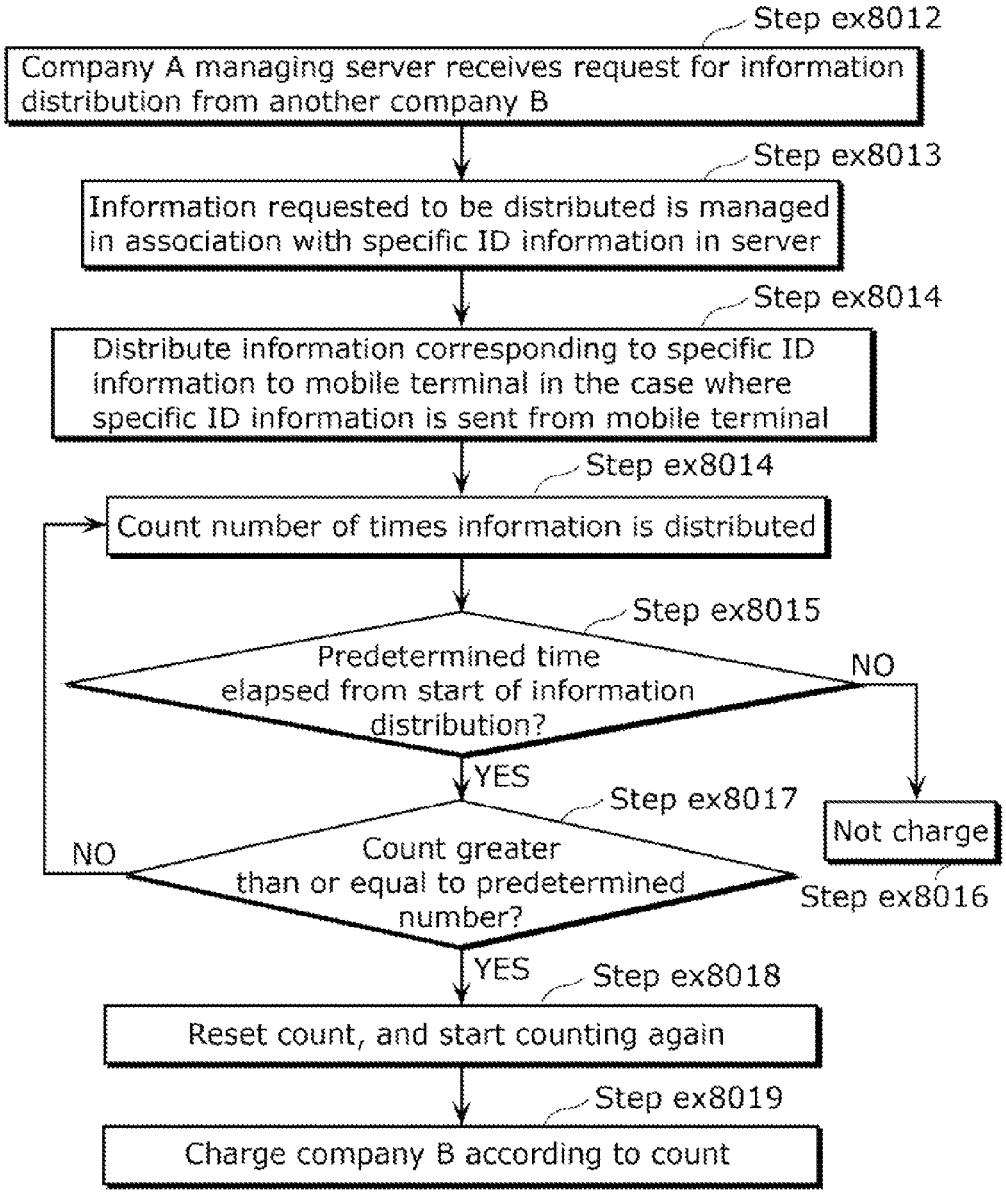

Step ex8005
Company A managing server receives request for information distribution from another company B
Step ex8006
Information requested to be distributed is managed in association with specific ID information in server
Step ex8007
Distribute information corresponding to specific ID information to mobile terminal in the case where specific ID information is sent from mobile terminal
Step ex8008
Predetermined time elapsed from start of information distribution?
NO
YES
Step ex8009
Count number of times information is distributed
Not charge
Step ex8011
Step ex8010
Charge company B according to count

FIG. 52


Step ex8012
Company A managing server receives request for information distribution from another company B
Step ex8013
Information requested to be distributed is managed in association with specific ID information in server
Step ex8014
Distribute information corresponding to specific ID information to mobile terminal in the case where specific ID information is sent from mobile terminal
Step ex8014
Count number of times information is distributed
Step ex8015
Predetermined time elapsed from start of information distribution?
NO
YES
Step ex8017
Count greater than or equal to predetermined number?
NO
Not charge
Step ex8016
YES
Step ex8018
Reset count, and start counting again
Step ex8019
Charge company B according to count

COMMUNICATION METHOD

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 14/260,351 filed on Apr. 24, 2014, which claims the benefit of U.S. Provisional Patent Application No. 61/921,132 filed on Dec. 27, 2013. The entire disclosure of the above-identified application, including the specification, drawings and claims is incorporated herein by reference in its entirety.

FIELD

The present invention relates to a method of communication between a mobile terminal such as a smartphone, a tablet terminal, or a mobile phone and a home electric appliance such as an air conditioner, a lighting device, or a rice cooker.

BACKGROUND

In recent years, a home-electric-appliance cooperation function has been introduced for a home network, with which various home electric appliances are connected to a network by a home energy management system (HEMS) having a function of managing power usage for addressing an environmental issue, turning power on/off from outside a house, and the like, in addition to cooperation of AV home electric appliances by internet protocol (IP) connection using Ethernet® or wireless local area network (LAN). However, there are home electric appliances whose computational performance is insufficient to have a communication function, and home electric appliances which do not have a communication function due to a matter of cost.

CITATION LIST

Patent Literature

Japanese Unexamined Patent Application Publication No. 2002-290335

SUMMARY

Technical Problem

However, the conventional method is limited to a case in which a device to which the method is applied has three color light sources such as an illuminator. The present invention solves this problem, and provides an information communication method that enables communication between various devices including a device with low computational performance.

Solution to Problem

In accordance with an aspect of the present disclosure, there is provided a communication method used in a terminal that includes a front camera as a first image capturing unit and a back camera as a second image capturing unit, the communication method including: switching between the front camera and the back camera according to an orientation of the terminal; and performing visible light communication by using the front camera or the back camera which is selected in the switching.

General and specific aspect(s) disclosed above may be implemented using a system, a method, an integrated circuit, a computer program, or a computer-readable recording medium such as a CD-ROM, or any combination of systems, methods, integrated circuits, computer programs, or computer-readable recording media.

Additional benefits and advantages of the disclosed embodiments will be apparent from the Specification and Drawings. The benefits and/or advantages may be individually obtained by the various embodiments and features of the Specification and Drawings, which need not all be provided in order to obtain one or more of such benefits and/or advantages.

Advantageous Effects

An information communication method disclosed herein enables communication between various devices including a device with low computational performance.

BRIEF DESCRIPTION OF DRAWINGS

These and other objects, advantages and features of the disclosure will become apparent from the following description thereof taken in conjunction with the accompanying drawings that illustrate a specific embodiment of the present disclosure.

FIG. **1** is a diagram illustrating an example of a situation of using a mobile terminal according to Embodiment 1.

FIG. **2** is a schematic diagram illustrating an example of the mobile terminal according to Embodiment 1.

FIG. **3** is a diagram illustrating an example of a situation of holding the mobile terminal to be horizontal according to Embodiment 1.

FIG. **4** is a diagram illustrating an example of a situation of holding the mobile terminal to be vertical according to Embodiment 1.

FIG. **5** is a schematic diagram illustrating examples of a shop map presented by the mobile terminal according to Embodiment 1.

FIG. **6** is a diagram illustrating an example of a product UI presented by the mobile terminal according to Embodiment 1.

FIG. **7** is a diagram illustrating an example of a situation where the product UI presented by the mobile terminal is operated, according to Embodiment 1.

FIG. **8** is a diagram illustrating user's actions of moving the mobile terminal in a direction from right to left according to Embodiment 1.

FIG. **9** is a diagram illustrating an example of a situation of using a watch-type device according to Embodiment 1.

FIG. **10** is a diagram illustrating a whole configuration of a communication system according to Embodiment 1.

FIG. **11** illustrates an example of a structure of pieces of information stored in a product information storage unit according to Embodiment 1.

FIG. **12** is a diagram illustrating an example of a layout of the product UI presented by the mobile terminal according to Embodiment 1.

FIG. **13** illustrates an example of a structure of pieces of information stored in a map information storage unit according to Embodiment 1.

FIG. **14** illustrates an example of a structure of pieces of information managed by a state management unit according to Embodiment 1.

FIG. **15** is a flowchart of processing performed by a lighting device according to Embodiment 1.

FIG. **16** is a flowchart of processing performed by the mobile terminal according to Embodiment 1.

FIG. **17** is a flowchart of ceiling light-related processing according to Embodiment 1.

FIG. **18** is a flowchart of base light-related processing according to Embodiment 1.

FIG. **19** is a flowchart of UI-related processing according to Embodiment 1.

FIG. **20** is a flowchart of UI processing for map information according to Embodiment 1.

FIG. **21** is a flowchart of UI processing for product information according to Embodiment 1.

FIG. **22** is a flowchart of entire display processing according to Embodiment 1.

FIG. **23** is a flowchart of preparation for display updating according to Embodiment 1.

FIG. **24** is a flowchart of display updating according to Embodiment 1.

FIG. **25** is a diagram illustrating a detailed structure of a light receiving control unit according to Embodiment 2.

FIG. **26** is a flowchart of illuminance pattern detection performed by a light receiving control unit according to Embodiment 2.

FIG. **27** is a diagram illustrating a detailed structure of a light receiving control unit according to Embodiment 3.

FIG. **28** is a flowchart of illuminance pattern detection performed by a light receiving control unit according to Embodiment 3.

FIG. **29** is a diagram illustrating an example of a situation of using a mobile terminal for detecting a movement of a line of sight according to Embodiment 4.

FIG. **30** is a diagram illustrating an example of a structure of the mobile terminal according to Embodiment 4.

FIG. **31** is a flowchart performed when making inquiry to a server according to Embodiment 4.

FIG. **32** illustrates an example of a structure of pieces of information managed by a database (DB) of identifiers according to Embodiment 4.

FIG. **33** is a diagram illustrating a detailed structure of a light receiving control unit according to Embodiment 5.

FIG. **34** is a diagram illustrating a detailed structure of a light receiving control unit according to Embodiment 6.

FIG. **35** is a diagram illustrating an example of a situation where imaging elements arranged in a line are exposed simultaneously with an exposure start time being shifted in order of lines according to Embodiment 7.

FIG. **36** is a diagram illustrating a situation where, after exposure of one exposure line ends, exposure of a next exposure line starts according to Embodiment 7.

FIG. **37** is a diagram illustrating a situation where, after exposure of one exposure line ends, exposure of a next exposure line starts according to Embodiment 7.

FIG. **38** is a diagram illustrating a situation where, before exposure of one exposure line ends, exposure of a next exposure line starts according to Embodiment 7.

FIG. **39** is a diagram illustrating influence of a difference in an exposure time in the case where an exposure start time of each exposure line is the same, according to Embodiment 7.

FIG. **40** is a diagram illustrating influence of a difference in an exposure time of exposure lines in the case where each exposure time is the same, according to Embodiment 7.

FIG. **41** is a diagram illustrating advantages of using a short exposure time in the case where each exposure line does not overlap in an exposure time, according to Embodiment 7.

FIG. **42** is a diagram illustrating a relation between a minimum change time of light source luminance, an exposure time, a time difference between exposure start times of the exposure lines, and a captured image, according to Embodiment 7.

FIG. **43** is a diagram illustrating a relation between a transition time of light source luminance and a time difference between exposure start times of the exposure lines, according to Embodiment 7.

FIG. **44** illustrates a relation between a high frequency noise of light source luminance and an exposure time, according to Embodiment 7.

FIG. **45** is a graph representing a relation between an exposure time and a magnitude of high frequency noise when the high frequency noise of the light source luminance is 20 microseconds, according to Embodiment 7.

FIG. **46** is a diagram illustrating a relation between an exposure time and a recognition success rate according to Embodiment 7.

FIG. **47** is a diagram illustrating an example of a method for observing luminance by a light emitting unit according to Embodiment 7.

FIG. **48** is a diagram illustrating an example of each mode of a receiving device according to Embodiment 7.

FIG. **49** is a diagram illustrating a service provision system according to Embodiment 8.

FIG. **50** is a flowchart of service provision according to Embodiment 8.

FIG. **51** is a flowchart of service provision according to a variation of Embodiment 8.

FIG. **52** is a flowchart of service provision according to another variation of Embodiment 8.

DESCRIPTION OF EMBODIMENTS

In accordance with an aspect of the present invention, there is provided a communication method used in a terminal that includes a front camera as a first image capturing unit and a back camera as a second image capturing unit, the communication method including: switching between the front camera and the back camera according to an orientation of the terminal; and performing visible light communication by using the front camera or the back camera which is selected in the switching.

In accordance with another aspect of the present invention, there is provided a communication method used in a terminal that includes a front camera as a first image capturing unit and a back camera as a second image capturing unit, the communication method including: switching between the front camera and the back camera at predetermined intervals; and performing visible light communication by using the front camera or the back camera which is selected in the switching.

For example, it is also possible that when the orientation of the terminal is substantially perpendicular to ground, the performing of visible light communication includes: performing, by using the back camera selected in the switching, visible light communication with a first device which is located in front of a user and emits visible light, thereby obtaining product information of a product rack provided with the first device; and displaying the product information on a display unit of the terminal, and when the orientation of the terminal is substantially parallel to ground, the performing of visible light communication includes: performing, by using the front camera selected in the switching, visible light communication with a second device which is located above the user and emits visible light, thereby obtaining position information of the second device; and displaying, on the display unit of the terminal, the position information as a

current position of the user together with map information of an area where the user is present.

For example, it is further possible that the terminal is included in a watch, the front camera is provided on a front surface of the watch, and the back camera is provided on a side surface of the watch, the front surface having a display unit that displays a time of the watch, and when the display unit of the watch is substantially parallel to ground, the performing of visible light communication includes: performing, by using the front camera, visible light communication with a second device which is located above the user and emits visible light, thereby obtaining position information of the second device; performing, by using the back camera, visible light communication with a first device which is located in front of the user and emits visible light, thereby obtaining product information of a product rack provided with the first device; and displaying one of the position information and the product information on the display unit of the terminal according to selection of the user, the position information being displayed as a current position of the user together with map information of an area where the user is present.

For example, it is still further possible that the performing of visible light communication includes inquiring a server about an identifier uniquely assigned to a device that emits visible light, thereby obtaining information related to the device corresponding to the identifier, the identifier being obtained through visible light communication, and when no information corresponds to the identifier as a result of the inquiring the server, the performing of visible light communication further includes displaying, on the display unit of the terminal, an error notification indicating that no information is related to the device.

For example, it is still further possible that the communication method further includes changing the product information displayed on the display unit of the terminal, wherein in the changing, the product information to be displayed on the display unit is changed by user's flicking on the display unit.

For example, it is still further possible that the communication method further includes changing the map information displayed on the display unit of the terminal, wherein in the changing, the map information to be displayed on the display unit is changed by user's flicking on the display unit.

For example, it is still further possible that the performing of visible light communication includes initializing an offset assigned to the map information, when the product information of the product rack provided with the first device is obtained by using the back camera selected in the switching after displaying the map information on the display unit of the terminal, and the performing of visible light communication includes initializing an offset assigned to the product information, when the position information is obtained as the current position of the user by using the front camera selected in the switching after displaying the product information on the display unit of the terminal.

For example, it is still further possible that the communication method further includes detecting a line of sight of the user, wherein in the switching, the back camera is selected when the orientation of the terminal is substantially perpendicular to ground, in the detecting, the line of the sight of the user is detected by using the front camera, and the performing of visible light communication includes: performing, by using the back camera selected in the switching, visible light communication with the first device that is located in front of the user and emits visible light, thereby obtaining product information of a first product rack provided with the first device; and, when a second product rack in the line of the sight detected in the detecting is different from the first product rack, displaying product information of the second product rack instead of the product information of the first product rack.

For example, it is still further possible that the terminal includes an image sensor having a plurality of exposure lines, and the communication method further includes: obtaining image data by sequentially starting exposure of the exposure lines of the image sensor at different times and capturing a subject in an exposure time of $\frac{1}{480}$ seconds or less to partially and temporally overlap exposure times of adjacent exposure lines among the exposure lines; obtaining identification information of the subject by demodulating a bright line pattern which appears in the image data and corresponds to the exposure lines; and providing a user of the terminal with service information associated with the identification information of the subject.

For example, it is still further possible that the communication method further includes: receiving a request for distribution of information from a requester; distributing the information requested from the requester as information corresponding to data obtained by the visible light; and performing information processing for charging the requester according to the distribution of the information.

In accordance with still another aspect of the present invention, there is provided a communication device that includes a front camera as a first image capturing unit and a back camera as a second image capturing unit, the communication device including: a switching unit configured to switch between the front camera and the back camera according to an orientation of a terminal; and a visible light communication unit configured to perform visible light communication by using the front camera or the back camera which is selected by the switching unit.

These general and specific aspects may be implemented to a system, a method, an integrated circuit, a computer program, and a computer-readable recording medium, such as a Compact Disc-Read Only Memory (CD-ROM), and may be implemented also to a desired combination of them.

Hereinafter, embodiments are specifically described with reference to the Drawings. However, the description in details beyond necessity may be omitted. For example, detailed explanation of well-known matters and repeated explanation of the same structure may be omitted. This is because unnecessarily redundant explanation is avoided below to facilitate understanding of those skilled in the art.

Furthermore, each of the embodiments described below is a general or specific example. The numerical values, shapes, materials, structural elements, the arrangement and connection of the structural elements, steps, the processing order of the steps etc. shown in the following embodiments are mere examples, and therefore do not limit the scope of the present invention. Therefore, among the structural elements in the following embodiments, structural elements not recited in any one of the independent claims representing the broadest concepts are described as arbitrary structural elements.

Embodiment 1

Embodiment 1 describes a communication device that switches between light receiving units for visible light communication.

The communication device according to the present embodiment is assumed to be included in a mobile terminal, such as a smartphone.

The following describes a situation of using a mobile terminal including the communication device according to the present embodiment.

FIG. **1** is a diagram illustrating an example of a situation of using the mobile terminal according to Embodiment 1. FIG. **2** is a schematic diagram illustrating an example of the mobile terminal according to Embodiment 1.

The communication device used by a user performs visible light communication with a ceiling light A**1101** provided on a ceiling so as to receive an ID transmitted from the ceiling light A**1101**. Furthermore, the communication device performs visible light communication with a base light (rack light) A**1103** in front of the user so as to receive an ID transmitted from the base light A**1103**.

The communication device is characterized by (i) including a plurality of light receiving units (image capturing units) each receiving visible light, and (ii) by selecting a suitable light receiving unit from among the light receiving units according to an attitude of the mobile terminal in order to receive a plurality of IDs through visible light communication with a plurality of devices provided at different positions, such as the ceiling light A**1101** and the base light A**1103**.

In the present embodiment, the communication device includes a front camera that is the first image capturing unit and a back camera that is the second image capturing unit. More specifically, for example, as illustrated in FIG. **2**, a mobile terminal A**1201** including the communication device has a front camera A**1202** (first image capturing unit) on the front, a back camera A**1203** (second image capturing unit) on the back, and a touch panel unit A**1204** on the front. The communication device switches between the front camera A**1202** (first image capturing unit) and the back camera A**1203** (second image capturing unit) according to an orientation of the terminal (mobile terminal) including the communication device, and thereby performs visible light communication using the switched camera.

The following describes a situation where visible light communication is performed by switching between the image capturing units according to an orientation of the mobile terminal including the communication device.

FIG. **3** is a diagram illustrating an example of a situation of holding the mobile terminal to be horizontal according to Embodiment 1. FIG. **4** is a diagram illustrating an example of a situation of holding the mobile terminal to be vertical according to Embodiment 1.

For example, as illustrated in FIG. **3**, when the user holds the mobile terminal A**1201** such that a display surface of the mobile terminal A**1201** faces a ceiling (in other words, the display surface is substantially parallel to the ground), the mobile terminal A**1201** determines by using an acceleration sensor in the mobile terminal A**1201** that the mobile terminal A**1201** is parallel to the ceiling (the ground), and therefore operates the front camera A**1202**. Here, operation of the back camera A**1203** may be stopped for saving power consumption.

While the ceiling light A**1101** is lighted, a light amount of the lighting is varied with a specific pattern (light emitting pattern), thereby performing visible light communication. For example, as illustrated in a region A**1301**, when the front camera A**1202** currently operating detects light emitted from the ceiling light A**1101**, the front camera A**1202** captures the light to perform the visible light communication. In other words, the mobile terminal A**1201** obtains an ID associated with the light emitting pattern of the ceiling light A**1101** through the visible light communication with the ceiling light A**1101**, and thereby changes actions according to a type of the ID.

Furthermore, for example, as illustrated in FIG. **4**, when the user holds the mobile terminal A**1201** to be perpendicular to the ground, the mobile terminal A**1201** determines by using the included acceleration sensor that the mobile terminal A**1201** does not face the ceiling light on the ceiling but faces the base light A**1103** provided on a wall or a rack A**1102**, and thereby operates the back camera A**1203**. Here, operation of the front camera A**1202** may be stopped for saving power consumption.

While the base light A**1103** is lighted, a light amount of the lighting is varied with a specific pattern (light emitting pattern), thereby performing visible light communication. When the back camera A**1203** currently operating detects the light emitted from the base light A**1103**, the back camera A**1203** captures the light to perform the visible light communication. In other words, the mobile terminal A**1201** obtains an ID associated with the light emitting pattern of the base light A**1103** through the visible light communication with the base light A**1103**, and thereby changes actions according to a type of the ID.

Next, an example of the action according to a type of an obtained ID is described.

FIG. **5** is a diagram illustrating examples of a shop map presented by the mobile terminal according to Embodiment 1.

As illustrated in FIG. **3**, if the mobile terminal A**1201** determines that the mobile terminal A**1201** is parallel to the ceiling (ground), the mobile terminal A**1201** transmits, to a server, an ID associated with a light emitting pattern obtained by visible light communication performed using the front camera A**1202**. The server searches out position information corresponding to the ID, and notifies the position information to the mobile terminal A**1201**.

When the position information is obtained from the server, the mobile terminal A**1201** presents the user with a map (map information) showing a user's current position, such as a shop map as illustrated in FIG. **5**, in which the obtained position information is presented as the user's current position.

As described above, if the orientation of the mobile terminal A**1201** is substantially parallel to the ceiling (the ground), the front camera A**1202** is used to perform visible light communication with the ceiling light A**1101** (second device) that is located above the user and emits visible light, so as to obtain position information of the ceiling light A**1101** (second device). The mobile terminal A**1201** displays, on a display unit of the mobile terminal A**1201**, the obtained position information together with map information of an area where the user is present.

It should be noted that the map information displayed on the display unit of the mobile terminal A**1201** may be changed by flicking. For example, if the user flicks on the display unit of the mobile terminal A**1201**, an offset position of the map information displayed on the display unit is changed.

FIG. **6** is a diagram illustrating an example of a product user interface (UI) presented by the mobile terminal according to Embodiment 1. FIG. **7** is a diagram illustrating an example of the situation where the product UI presented by the mobile terminal is operated, according to Embodiment 1.

If it is determined that the mobile terminal A**1201** is perpendicular to the ground as illustrated in FIG. **4**, the mobile terminal A**1201** transmits, to the server, an ID which is obtained through visible light communication using the front camera A**1202**. The server searches a database for a product type and stock of a product rack associated with the ID, and generates an image showing a stock amount of products according to the found product type and stock. Here, for example, as illustrated in FIG. **6**, the server generates an image in which an image of products in stock is superimposed

on an image of products arranged on the product rack. Then, the server transmits the generated image to the mobile terminal A**1201**.

The mobile terminal A**1201** presents, on the display unit, the image received from the server, namely, the image showing a stock amount of the products.

As described above, when the orientation of the mobile terminal A**1201** is substantially perpendicular to the ground, the back camera A**1203** is used to perform visible light communication with the base light A**1103** (first device) that is located in front of the user and emits visible light, so as to obtain product information of the product rack provided with the base light A**1103** (first device). The mobile terminal A**1201** displays the obtained product information on the display unit of the mobile terminal A**1201**.

It should be noted that the image displayed on the display unit of the mobile terminal A**1201** to show the stock amount of the products may be changed by flicking. For example, if the user flicks on the display unit of the mobile terminal A**1201**, an offset of the image displayed on the display unit to show the stock amount of the products is changed, or the image itself is changed, thereby changing the product information displayed on the display unit.

When the server transmits the generated image (image data) to the mobile terminal A**1201**, it is also possible to transmit a plurality of images (plural pieces of image data) to the mobile terminal A**1201**. For example, as illustrated in FIG. **7**, the server sequentially transmits an image A**1701** of a rack with a small stock amount and an image A**1703** of a rack with a large stock amount, and the mobile terminal A**1201** therefore displays the image A**1701** of the rack with the small stock amount. According to a screen operation of the user, such as flicking, the mobile terminal A**1201** displays sequentially the image A**1701** of the rack with the small stock amount, then an image A**1702** showing a scrolling transition, and finally the image A**1703** of the rack with the large stock amount. As a result, the user can check product stocks more instinctly and more easily.

FIG. **8** is a diagram illustrating user's actions of moving the mobile terminal in a direction from right to left according to Embodiment 1.

As described above, the mobile terminal A**1201** can switch presented details according to a received ID. Therefore, for example, as illustrated in FIG. **8**, it is possible to switch pieces of product information of a rack A**1801** and a rack A**1802** which the user has viewed. In other words, when the user causes the mobile terminal A**1201** to face the rack A**1801** and then face the rack A**1802**, the mobile terminal A**1201** sequentially receives an ID from a base light A**1803** and an ID from a base light A**1804**. Therefore, the mobile terminal A**1201** can sequentially display product information corresponding to the ID received from the base light A**1803** and then product information corresponding to the ID received from the base light A**1804**.

As described above, the mobile terminal A**1201** can present the user with pieces of information corresponding to an ID obtained by visible light communication with a device selected according to an attitude of the user.

It should be noted that the terminal including the communication device according to the present embodiment is not limited to the mobile terminal A**1201** having image capturing units on the front and on the back. The terminal may be a watch. The following describes an example of the situation where the terminal including the communication terminal according to the present embodiment is a watch (watch-type device) with reference to FIG. **9**.

FIG. **9** is a diagram illustrating an example of the situation of using a watch-type device according to Embodiment 1.

The watch-type device A**1901** illustrated in FIG. **9** includes a light receiving unit A**1902** on the front part and a light receiving unit A**1903** on the side part. The light receiving unit A**1902** corresponds to the above-described front camera A**1202** (first image capturing unit), and the light receiving unit A**1903** corresponds to the above-described back camera A**1203** (second image capturing unit).

The watch-type device A**1901** also includes an acceleration sensor.

If, for example, as illustrated in FIG. **9**, the front part of the watch-type device A**1901** faces a direction parallel to the ground, the watch-type device A**1901** operates the light receiving unit A**1902** and the light receiving unit A**1903**. The light receiving unit A**1902** receives light emitted from a ceiling light A**1904**, and the light receiving unit A**1903** receives light emitted from a base light A**1905**.

More specifically, the watch-type device A**1901** uses the light receiving unit A**1902** to perform visible light communication with the ceiling light A**1904** (second device) that is located above the user and emits visible light, so as to obtain position information of the ceiling light A**1904** (second device). On the other hand, the watch-type device A**1901** uses the light receiving unit A**1903** to perform visible light communication with the base light A**1905** (first devices) that is located in front of the user and emits visible light, so as to obtain product information of the product rack provided with the base light A**1905** (first device). Then, according to the user's selection, the obtained position information is displayed as a current position of the user on the display unit together with map information of an area where the user is present, or the obtained product information is displayed on the display unit.

It is also possible that the watch-type device A**1901** may switch between the light receiving unit A**1902** and the light receiving unit A**1903** at predetermined intervals, and the switched light receiving unit A**1902** or the light receiving unit A**1903** is used to perform visible light communication.

As described above, the mobile terminal or the watch including the communication device according to the present embodiment is used.

The following describes the structure of the communication device according to the present embodiment.

FIG. **10** is a diagram illustrating a whole configuration of a communication system according to Embodiment 1.

The communication system according to the present embodiment includes at least a mobile terminal A**11001**, a lighting device A**11002**, a lighting device A**11003**, and a server device A**11015**.

[Structure of Lighting Device A**11002**]

The lighting device A**11002** includes an ID storage unit A**11004**, an encoding unit A**11005**, an illuminance pattern storage unit A**11006**, and a light emitting unit A**11007**. The lighting device A**11002** corresponds to the second device, such as the ceiling light A**1101** illustrated in FIG. **1** or the ceiling light A**1904** illustrated in FIG. **9**.

The ID storage unit A**11004** is a memory region. In the ID storage unit A**11004**, identifiers each uniquely identifying an individual, such as media access control (MAC) addresses, are previously written.

When the lighting device A**11002** is supplied with power, the encoding unit A**11005** reads an ID from the ID storage unit A**11004**, and converts the ID to an illuminance pattern of the lighting, in other words, an illuminance of the lighting at corresponding timing, and stores the illuminance pattern to the illuminance pattern storage unit A**11006**.

When the above-described start phase is completed, the light emitting unit **A11007** controls light emission by updating illuminance at a high speed according to the pattern stored in the illuminance pattern storage unit **A11006**. The lighting device **A11002** thereby performs illuminance control (visible light communication) based on the ID.

[Structure of Lighting Device **A11003**]

Like the lighting device **A11002**, the lighting device **A11003** includes an ID storage unit **A11018**, an encoding unit **A11009**, an illuminance pattern storage unit **A11010**, and a light emitting unit **A11011**. The lighting device **A11003** corresponds to the first device, such as the base light **A1103** illustrated in FIG. **1** and the base light **A1905** illustrated in FIG. **9**.

The ID storage unit **A11008** is a memory region. In the ID storage unit **A11008**, identifiers each uniquely identifying an individual, such as MAC addresses, are previously written.

When the lighting device **A11003** is supplied with power, the encoding unit **A11019** reads an ID from the ID storage unit **A11008**, and converts the ID to an illuminance pattern of the lighting, in other words, an illuminance of the lighting at corresponding timing, and stores the illuminance pattern to the illuminance pattern storage unit **A11010**.

When the above-described start phase is completed, the light emitting unit **A11011** controls light emission by updating illuminance at a high speed according to a pattern stored in the illuminance pattern storage unit **A11010**. The lighting device **A11003** thereby performs illuminance control (visible light communication) based on the ID.

[Structure of Mobile Terminal **A11001**]

Subsequently, the structure of the mobile terminal **A11001** is described.

The mobile terminal **A11001** includes a light receiving control unit **A11012**, an ID storage unit **A11013**, a DB management unit **A11014**, a product information storage unit **A11016**, a map information storage unit **A11017**, a display unit **A11018**, a state management unit **A11019**, and an UI unit **A11020**. The mobile terminal **A11001** corresponds to the mobile terminal **A1201** illustrated in FIG. **2** or the watch-type device illustrated in FIG. **9**.

[Light Receiving Control Unit **A11012**]

The light receiving control unit **A11012** detects an illuminance pattern of the light emitting unit **A11007** and an illuminance pattern of the light emitting unit **A11011**, then converts the detected patterns to IDs, and stores the IDs to the ID storage unit **A11013**. In the case of the present embodiment, since an illuminance pattern of the light emitting unit **A11007** or the light emitting unit **A11011** is detected, the ID stored in the ID storage unit **A11013** is identical to either an ID stored in the ID storage unit **A11004** or an ID stored in the ID storage unit **A11008**.

[Product Information Storage Unit **A11016**]

Next, the product information storage unit **A11016** is described.

FIG. **11** illustrates an example of a structure of pieces of information stored in a product information storage unit according to Embodiment 1. FIG. **12** is a diagram illustrating an example of a layout of the product UI presented by the mobile terminal according to Embodiment 1.

For example, as illustrated in FIG. **11**, in the product information storage unit **A11016**, there are stored a validity flag **A11101**, rack exterior **A11102**, rack interior **A11103**, product type information **A11104**, product stock information **A11105** are stored.

The validity flag **A11101** indicates whether or not to render product stock information. The validity flag **A11101** has a value indicating TRUE or a value indicating FALSE. If the value is TRUE, the display unit **A11018** renders the product stock information.

The rack exterior **A11102** indicates an exterior of a rack to be drawn. As the rack exterior **A11102**, a height and a width of a plain scale of the rack are recorded. Based on the plain scale information, the display unit **A11018** performs the rendering to draw the rack within the image. For example, the display unit **A11018** renders an outer line of the rack as a layout illustrated in FIG. **12**.

The rack interior **A11103** indicates the number of shelves in the rack and a height ratio of each of the shelves to the rack. Based on these pieces of information, the display unit **A11018** renders the internal boards of the shelves with intervals as illustrated in FIG. **12**.

The product type information **A11104** stores the number of product variations and pieces of image data of respective products. For example, when the format of the image data received from the server device **A11015** is PNG data, the PNG data is directly arranged in the product type image data corresponding to the product type information **A11104**. Then, the display unit **A11018** develops the PNG data to a cache region (not illustrated) immediately prior to the rendering, and renders details of the cache region to present the user with the image of the products.

The product stock information **A11105** indicates (a) the number of stocked products, and (b) a type and coordinate information of the stocked products to be rendered. Among pieces of coordinate information in FIG. **11**, x-coordinates indicate "where a target product is in a product rack when it is counted from the left", y-coordinate indicates "where a shelf with a target product is in a product rack as being counted from the top", and z-coordinate indicates "where a rack with a target product is among the racks arranged to the depth direction as being counted from the front." The display unit **A11018** renders the product image identified by a product type number on the coordinates matching these pieces of coordinate information.

[Map Information Storage Unit **A11017**]

Next, the map information storage unit **A11017** is described.

FIG. **13** illustrates an example of a structure of pieces of information stored in the map information storage unit **A11017** according to Embodiment 1.

For example, as illustrated in FIG. **13**, the map information storage unit **A11017** stores a validity flag **A11301**, a data length of a map image (map image data length) **A11302**, and a map image **A11303**.

The validity flag **A11301** indicates whether or not to render the map information. The validity flag **A11301** has a value indicating TRUE or a value indicating FALSE. If the value is TRUE, the display unit **A11018** renders the map information.

The map image **A11303** stores information of image data itself of a map. For example, if a format of image data received from the server device **A11015** is PNG data, the map image **A11303** stores the PNG data directly.

The map image data length **A11302** indicates a data length of the map image **A11303**. For example, if a format of image data received from the server device **A11015** is PNG data, the display unit **A11018** develops the PNG data to a cache region (not illustrated) immediately prior to rendering, and renders details of the cache region to present the user with the image of the products.

[State Management Unit A11019]

Next, the state management unit A11019 is described.

FIG. 14 illustrates an example of a structure of pieces of information managed by the state management unit according to Embodiment 1.

As illustrated in FIG. 14, the state management unit A11019 includes an error flag A11601, a previous frame drawing type A11602, a display rack depth A11603, a map offset X A11604, a map offset Y A11605, a previously-obtained ID A11606.

An initial value of the previously-obtained ID A11606 is an invalid value. According to the present embodiment, it is assumed that the invalid value=−1.

The error flag A11601 has a value indicating TRUE or a value indicating FALSE. The state management unit A11019 sets the error flag A11601 to TRUE, if, for example, an ID transmitted to the server device A11015 is an invalid ID that is not related to any of the lighting devices (lighting device A11002, lighting device A11003). Furthermore, for example, if the error flag A11601 is TRUE, the display unit A11018 notifies the user that receiving is failed.

Values of the display rack depth A11603, the map offset X A11604, and the map offset Y A11605 are updated by the UI unit A11020, when the user operates the touch panel unit A1204.

[DB Management Unit A11014]

Next, the DB management unit A11014 is described.

The DB management unit A11014 reads an ID from the ID storage unit A11013, and then inquires the server device A11015 whether or not the readout ID matches the recorded ID.

If it is determined that the readout ID matches, for example, the ID of the ceiling light on the ceiling, the DB management unit A11014 requests the server device A11015 to transmit the map information as illustrated in FIG. 5, namely, map image showing the ceiling light and its periphery. As a result of the request, the DB management unit A11014 obtains the map image (map information) as illustrated in FIG. 5 and stores it to the map information storage unit A11017. Then, the DB management unit A11014 sets the validity flag A11301 of the map information storage unit A11017 to TRUE, sets the validity flag of the product information storage unit A11016 to FALSE, and sets the error flag A11601 to FALSE.

On the other hand, if it is determined that the readout ID is, for example, an ID of any of the base lights provided on product racks, the DB management unit A11014 requests the server device A11015 to transmit the product information illustrated in FIG. 11. As a result of the request, the DB management unit A11014 stores the obtained product information to the product information storage unit A11016. Then, the DB management unit A11014 sets the validity flag A11301 of the map information storage unit A11017 to FALSE, sets the validity flag of the product information storage unit A11016 to TRUE, and sets the error flag A11601 to FALSE.

It should be noted that, if the ID transmitted to the server device A11015 is an invalid ID that is not related to any of the ceiling light and the base lights, the DB management unit A11014 sets the validity flag A11301 of the map information storage unit A11017 to FALSE, sets the validity flag of the product information storage unit A11016 to FALSE, and sets the error flag A11601 to TRUE.

[UI Unit A11020]

Subsequently, the UI unit A11020 is described.

The UI unit A11020 is cooperated with the touch panel unit A1204.

If, for example, the validity flag A11101 of the product information storage unit A11016 is TRUE and the user flicks on the touch panel unit A1204, the UI unit A11020 updates the values of the map offset X A11604 and the map offset Y A11605. For example, if the user flicks to the right on the touch panel unit A1204, the UI unit A11020 increases the value of the map offset X A11604 by an amount of the flicking. If the user flicks to the left on the touch panel unit A1204, the UI unit A11020 decreases the value of the map offset X A11604 by an amount of the flicking. Furthermore, for example, if the user flicks upwards on the touch panel unit A1204, the UI unit A11020 decreases the value of the map offset Y A11605. If the user flicks downwards on the touch panel unit A1204, the UI unit A11020 increases the value of the map offset Y A11605.

On the other hand, for example, if the validity flag A11301 of the map information storage unit A11017 is TRUE, the UI unit A11020 updates the value of the display rack depth A11603. For example, if the user flicks to the right on the touch panel unit A1204, the UI unit A11020 increases the value of the display rack depth A11603. If the user flicks to the left on the touch panel unit A1204, the UI unit A11020 decreases the value of the display rack depth A11603.

When the value of the display rack depth A11603 exceeds a maximum value of z coordinates of a product of the product stock information A11105, the UI unit A11020 resets the value of the display rack depth A11603 to zero. When the value of the display rack depth A11603 becomes smaller than zero, the UI unit A11020 sets the value of the display rack depth A11650 to the maximum value of the z coordinates of the product of the product stock information A11105.

[Display Unit A11018]

The display unit A11018 renders the above-described map information or product information to be displayed. In addition, the display unit A11018 updates displayed details according to the above-described processing.

When processing for updating the displayed details (updating) is to be performed, the display unit A11018 first performs preparation for display updating which is described below.

If the validity flag A11101 of the product information storage unit A11016 is TRUE and the previous frame drawing type A11602 is not product information, the display unit A11018 determines that the state of the rack to be displayed is to be initialized, and therefore resets the value of the display rack depth A11603 to zero.

In other words, if, after displaying product information on the display unit A11018 of the mobile terminal A11001, a newly switched first image capturing unit (for example, front camera A1202) is used to obtain position information as a current position of the user, an offset assigned to the product information is initialized.

Likewise, if the validity flag A11301 of the map information storage unit A11017 is TRUE and the previous frame drawing type A11602 is not map information, the display unit A11018 determines that the state of the map to be displayed is to be initialized, and therefore resets the values of the map offset X A11604 and the map offset Y A11605 to zero. In other words, if, after displaying map information on the display unit A11018 of the mobile terminal A11001, a newly switched second image capturing unit (for example, back camera A1203) is used to obtain product information of a product rack provided with the first device (lighting device A11003), an offset assigned to the map information is initialized.

It is also possible that, if the previously-obtained ID in the state management unit A11019 and the ID in the ID storage unit A11013 have different values, the display unit A11018

determines that the display state is to be initialized, and therefore resets the values of the map offset X A**11604**, the map offset Y A**11605**, and the display rack depth A**11603** to zero. In this case, data of the ID storage unit A**11013** is copied to the previously-obtained ID in the state management unit A**11019**.

Furthermore, for the preparation for display updating, in the state management unit A**11019**, if the validity flag A**11101** of the product information storage unit A**11016** is TRUE, the previous frame drawing type A**11602** is set to "product information", and if the validity flag A**11301** of the map information storage unit A**11017** is TRUE, the previous frame drawing type A**11602** is set to "map information". If the error flag A**11601** is TRUE, the previous frame drawing type A**11602** is set to "error".

It is assumed that the above-described preparation for display updating is completed and therefore either the validity flag A**11301** of the map information storage unit A**11017** and the validity flag of the product information storage unit A**11016** is TRUE.

In this case, if the validity flag A**11301** of the map information storage unit A**11017** is TRUE, the display unit A**11018** performs rendering to display the map information as illustrated in FIG. **5**. Furthermore, if the validity flag of the product information storage unit A**11016** is TRUE, the display unit A**11018** performs rendering to display a product stock state as illustrated in FIG. **12**. On the other hand, if the error flag A**11601** is TRUE, the display unit A**11018** updates displayed details to notify that an unauthorized ID is received.

[Processing Flow of Communication System]

Sequentially, the processing flow of the communication system according to the present embodiment is described.

[Processing Flow of Lighting Device]

FIG. **15** is a flowchart of processing performed by the lighting device according to Embodiment 1.

The following describes the processing flow of the lighting device A**11002** with reference to FIG. **15**.

First, the lighting device A**11002** is supplied with power, and thereby the processing flow starts (SA**11401**).

Next, the encoding unit A**11005** reads an ID from the ID storage unit A**11004** (SA**11402**).

Next, the encoding unit A**11005** performs encoding to convert the ID to an illuminance pattern of lighting, namely, an illuminance of lighting at each timing (SA**11403**).

Next, the encoding unit A**11005** stores the illuminance pattern to the first illuminance pattern storage unit A**11006** (SA**11404**).

Next, because the above start phase is completed, the light emitting unit A**11007** reads the illuminance pattern from the illuminance pattern storage unit A**11006** (SA**11405**), and controls light emission by updating illuminance at a high speed according to the pattern indicated by the illuminance pattern (SA**11406**).

By the above processing flow, the lighting device A**11002** performs illuminance control (visible light communication) based on the ID.

Next, the lighting device A**11003** is also described.

First, the lighting device A**11003** is supplied with power, and thereby a processing flow starts (SA**11401**). The encoding unit A**11009** reads an ID from the ID storage unit A**11008** (SA**11402**), performs encoding to convert the ID to an illuminance pattern of lighting, namely, an illuminance of lighting at each timing (SA**11403**), and stores the illuminance pattern to the illuminance pattern storage unit A**11010** (SA**11404**).

When the above start phase is completed, the light emitting unit A**11011** reads the illuminance pattern from the illuminance pattern storage unit A**11010** (SA**11405**), and controls light emission by updating illuminance at a high speed according to the pattern indicated by the illuminance pattern (SA**11406**).

By the above processing flow, the lighting device A**11003** performs illuminance control based on the ID.

[Processing Flow of Mobile Terminal A**11001**]

Subsequently, the flow of the mobile terminal A**11001** is described with reference to FIG. **16**.

FIG. **16** is a flowchart of processing performed by the mobile terminal according to Embodiment 1.

First, the light receiving control unit A**11012** switches a shutter speed to be high (SA**11500**).

Next, the light receiving control unit A**11012** detects an illuminance pattern of the light emitting unit A**11007** or the light emitting unit A**11011**, then decodes the detected illuminance pattern to convert the pattern to an ID (SA**11501**), and stores the ID to the ID storage unit A**11013** (SA**11502**).

Next, the DB management unit A**11014** reads the ID from the ID storage unit A**11013** and makes inquiry to the server device A**11015** (SA**11503**), and determines whether or not the readout ID matches the recorded ID (SA**11504**, SA**11506**).

If it is determined at SA**11504** that the readout ID matches an ID of any of ceiling lights on the ceiling (Yes at SA**11504**), then the DB management unit A**11014** performs processing related to ceiling light (SA**11505**).

On the other hand, if it is determined at SA**11506** that the ID matches an ID of any of the base lights provided on product racks (Yes at SA**11506**), the DB management unit A**11014** performs processing related to base light (SA**11507**).

It should be noted that, if the ID transmitted to the server device A**11015** is an invalid ID that is not related to any of the ceiling light and the base lights, the DB management unit A**11014** sets the validity flag A**11301** of the map information storage unit A**11017** to FALSE, sets the validity flag of the product information storage unit A**11016** to FALSE, and sets the error flag A**11601** to TRUE. The display unit A**11018** displays an error notification indicating that there is no information related to lighting device (SA**11508**). In other words, the mobile terminal A**11001** inquires the server device A**11015** about an identifier uniquely assigned to the lighting device which is obtained by the visible light communication with the lighting device emitting visible light, thereby obtaining information of the lighting device which is associated with the identifier. However, if the mobile terminal A**11001** makes inquiry to the server device A**11015** but there is no information associated with the identifier, the mobile terminal A**11001** displays, on the display unit A**11018**, an error notification indicating that there is no information related to the lighting device.

[Flow of Processing Related to Ceiling Light]

Next, the ceiling light-related processing (SA**11505**) is described.

FIG. **17** is a flowchart of processing related to the ceiling light according to Embodiment 1.

First, as illustrated in FIG. **5**, the DB management unit A**11014** transmits, to the server device A**11015**, a request for transmission of a map image showing a target ceiling light and its periphery (SA**11701**).

Next, the DB management unit A**11014** obtains the map image illustrated in FIG. **5** and stores it to the map information storage unit A**11017** (SA**11702**).

Then, the DB management unit A**11014** sets the validity flag A**11301** of the map information storage unit A**11017** to TRUE, and sets the validity flag of the product information storage unit A**11016** to FALSE (SA**11703**).

[Flow of Processing Related to Base Light]

Next, the base light-related processing (SA11507) is described.

FIG. 18 is a flowchart of processing related to the base light according to Embodiment 1.

First, the DB management unit A11014 requests the server device A11015 for the product information illustrated in FIG. 11 (SA11801).

Next, the DB management unit A11014 stores the obtained product information to the product information storage unit A11016 (SA11802).

Then, the DB management unit A11014 sets the validity flag A11301 of the map information storage unit A11017 to FALSE, and sets the validity flag of the product information storage unit A11016 to TRUE (SA11803).

[Processing Flow of UI Unit A11020]

Subsequently, the UI unit A11020 is described with reference to FIG. 19.

FIG. 19 is a flowchart of processing related to UI according to Embodiment 1.

The UI unit A11020 is cooperated with the touch panel unit A1204, as described previously.

If, at SA119001, the validity flag A11301 of the map information storage unit A11017 is TRUE (yes at S11901), the UI unit A11020 performs UI processing for map information (S11902).

On the other hand, if at SA119003, the validity flag A11101 of the product information storage unit A11016 is TRUE (yes at S11903), then the UI unit A11020 performs UI processing for product information (S11904).

[Flow of UI Processing for Map Information]

Subsequently, the UI processing for map information (S11802) is described.

FIG. 20 is a flowchart of UI processing for map information according to Embodiment 1.

First, when the UI processing for map information starts (SA11902), the UI unit A11020 determines whether or not the user flicks to the right on the touch panel unit A1204 (SA12001).

At SA12001, if the user flicks to the right on the touch panel unit A1204 (yes at SA12001), the UI unit A11020 increases the value of the map offset X A11604 by an amount of the flicking (SA12002).

At SA12003, if the user flicks to the left on the touch panel unit A1204 (yes at SA12003), the UI unit A11020 decreases the value of the map offset X A11604 (SA12004).

At SA12005, if the user flicks upwards on the touch panel unit A1204 (yes at SA12005), the UI unit A11020 decreases the value of the map offset Y A11605 (SA12006).

At SA12007, if the user flicks downwards on the touch panel unit A1204 (yes at SA12007), the UI unit A11020 increases the value of the map offset Y A11605 (SA12008).

As described above, when the user flicks on the touch panel unit A1204, the UI unit A11020 updates the values of the map offset X A11604 and the map offset Y A11605.

[Flow of UI Processing for Product Information]

Subsequently, the UI processing for product information (S11804) is described.

FIG. 21 is a flowchart of UI processing for product information according to Embodiment 1.

First, when the UI processing for product information starts (SA11904), the UI unit A11020 determines whether or not the user flicks to the right on the touch panel unit A1204 (SA12101).

At SA12101, if the user flicks to the right on the touch panel unit A1204 (yes at SA12101), the UI unit A11020 increases the value of the display rack depth A11603 (SA12102).

At SA12103, if the user flicks to the left on the touch panel unit A1204 (yes at SA12103), the UI unit A11020 decreases the value of the display rack depth A11603 (SA12104).

At SA12105, when the value of the display rack depth A11603 exceeds a maximum value of z coordinates of a product of the product stock information A11105, the UI unit A11020 resets the value of the display rack depth A11603 to zero (SA12106).

On the other hand, at SA12107, when the value of the display rack depth A11603 becomes smaller than zero (yes at SA12107), the UI unit A11020 sets the value of the display rack depth A11603 to the maximum value of the z coordinates of the product of the product stock information A11105 (SA12108).

As described above, the UI unit A11020 updates the display rack depth A11603.

[Processing Flow of Display Unit A11018]

Subsequently, the processing flow of the display unit A11018 is described.

FIG. 22 is a flowchart of entire display processing according to Embodiment 1. FIG. 23 is a flowchart of preparation for display updating according to Embodiment 1. FIG. 24 is a flowchart of the display updating according to Embodiment 1.

As illustrated in FIG. 22, when display starts, the display unit A11018 performs preparation for display updating before performing the display updating (SA12201). Then, the display unit A11018 performs the display updating after performing the preparation (SA12202).

Here, the preparation for display updating (SA12201) is described in more detail with reference to FIG. 23.

When the preparation for display updating starts, the display unit A11018 confirms whether or not product information is valid as seen in FIG. 23 (SA12301).

If the validity flag A11101 of the product information storage unit A11016 is TRUE (yes at SA12301) and the previous frame drawing type A11602 is not product information (no at SA12302), the display unit A11018 determines that the state of the rack to be displayed is to be initialized and therefore resets the value of the display rack depth A11603 to zero (SA12303).

Next, at SA12304, the display unit A11018 confirms whether or not map information is valid (SA12304).

If the validity flag A11301 of the map information storage unit A11017 is TRUE (yes at SA12304) and the previous frame drawing type A11602 is not map information (no at SA12305), the display unit A11018 determines that the state of the map to be displayed is to be initialized, and therefore resets the values of the map offset X A11604 and the map offset Y A11605 to zero (SA12306).

Next, at SA12307, the display unit A11018 confirms whether or not an ID is updated (SA12307).

If the previously-obtained ID in the state management unit A11019 and the ID in the ID storage unit A11013 have different values (yes at SA12307), the display unit A11018 determines that the display state is to be initialized, and therefore resets the values of the map offset X A11604, the map offset Y A11605, and the display rack depth A11603 to zero (SA12308).

Next, at SA12309, the display unit A11018 copies data of the ID storage unit A11013 to the previously-obtained ID of the state management unit A11019, thereby updating the previous ID (SA12309).

Next, the display unit A11018 updates the previous frame drawing type (SA12310). More specifically, if the validity flag A11101 of the product information storage unit A11016 is TRUE, the display unit A11018 sets the previous frame

drawing type A11602 to "product information". If the validity flag A11301 of the map information storage unit A11017 is TRUE, the display unit A11018 sets the previous frame drawing type A11602 to "map information". If the error flag A11601 is TRUE, the display unit A11018 sets the previous frame drawing type A11602 to "error".

Subsequently, the display updating (SA12202) is described with reference to FIG. 24.

When the display updating starts, the display unit A11018 confirms whether or not the map information is valid as illustrated in FIG. 24 (SA12301).

If the validity flag A11301 of the map information storage unit A11017 is TRUE (yes at SA12401), the display unit A11018 reads the value of the map offset X A11604 and the value of the map offset Y A11606 (SA12402), and renders the map information as illustrated in FIG. 5 by shifting it by the values of the offsets (SA12403).

At S12401, if the validity flag of the map information is invalid, the display unit A11018 confirms whether or not the product information is valid (SA12304).

If the validity flag of the product information storage unit A11016 is TRUE (yes at SA12404), the display unit A11018 reads the value of the display rack depth A11603 (SA12404), and renders the product stock state as illustrated in FIG. 12 to present the image of the rack indicated by the display rack depth A11603 (SA12406).

At S12404, if the validity flag of the product information is invalid (no at SA12404) and the error flag A11601 is TRUE, then the display unit A11018 updates the displayed details to notify that an unauthorized ID is received (SA12407).

Embodiment 2

In Embodiment 2, a structure and a flow of a light receiving control unit A11012 are described in detail. The other structure is the same as described in Embodiment 1 and therefore not described again below.

[Detailed Structure of Light Receiving Control Unit A11012]

First, the detailed structure of the light receiving control unit A11012 according to Embodiment 2 is described.

FIG. 25 is a diagram illustrating the detailed structure of the light receiving control unit according to Embodiment 2.

As illustrated in FIG. 25, the light receiving control unit A11012 according to Embodiment 2 includes a light receiving unit A12501, a light receiving unit A12502, a selector A12503, an acceleration detection unit A12504, a light receiving signal storage unit A12505, a decoding unit A12506, and a threshold storage unit A12507.

The light receiving unit A12501 corresponds to, for example, the front camera A1202 (first image capturing unit) according to Embodiment 1, and the light receiving unit A12502 corresponds to, for example, the back camera A1203 (second image capturing unit) according to Embodiment 1.

The selector A12503 selects one of the two light receiving units to be operated.

The acceleration detection unit A12504 detects an acceleration of the mobile terminal A11011 to provide the selector A12503 with information necessary in the selection.

The light receiving signal storage unit A12505 stores light receiving signal obtained from the light receiving unit A12501 or the light receiving unit A12502 via the selector A12503.

The decoding unit A12506 reads the light receiving signal from the light receiving signal storage unit A12505, then decodes the light receiving signal to an ID and stores the resulting ID to the ID storage unit A11013.

The threshold storage unit A12507 previously holds a first threshold and a second threshold. These thresholds are used in a determination as to, based on an acceleration detected by the selector A12503, whether or not the mobile terminal A11011 including the light receiving control unit A11012 is parallel to the ground.

[Processing of Light Receiving Control Unit]

Subsequently, the processing flow of the light receiving control unit A11012 according to Embodiment 2 is described.

FIG. 26 is a flowchart of illuminance pattern detection performed by the light receiving control unit according to Embodiment 2.

First, after starting (SA11501), the light receiving control unit A11012 detects, by using the acceleration detection unit A12504, an acceleration in a back surface direction of the mobile terminal A11011 (SA12601).

Next, the light receiving control unit A11012 compares the detected acceleration to the thresholds stored in the threshold storage unit A12507, thereby determining whether or not the light receiving unit A12501 (front camera) faces upwards (SA12602).

At SA12602, if the acceleration is greater than the first threshold, the light receiving control unit A11012 determines that the light receiving unit A12501 (front camera) faces upwards in respect with the ground (yes at SA12602) and therefore selects the light receiving unit A12501 (front camera) (SA12603). More specifically, if the acceleration is greater than the first threshold, this means that a greater acceleration, in other words, a gravity acceleration occurs in the back surface direction of the mobile terminal A11011. Therefore, the light receiving control unit A11012 can determine that the mobile terminal A11011 is parallel to the ground and the light receiving unit A12501 (front camera) faces upwards in respect with the ground. Then, the light receiving control unit A11012 selects or operates the light receiving unit A12501.

On the other hand, at SA12602, even if the acceleration is smaller than or equal to the second threshold, the light receiving control unit A11012 determines that the light receiving unit A12501 (front camera) does not face upwards in respect with the ground (no at SA12602), and selects the light receiving unit A12502 (back camera) (SA12604). More specifically, if the acceleration is smaller than or equal to the second threshold, this means that the gravity acceleration hardly occurs in the back surface direction of the mobile terminal A11011. Therefore, the light receiving control unit A11012 determines that the mobile terminal A11011 is not parallel to the ground and the light receiving unit A12502 (back camera) faces a wall or a rack. Then, the light receiving control unit A11012 selects or operates the light receiving unit A12502 (back camera).

Next, the light receiving control unit A11012 obtains still pictures (SA12605). More specifically, in the above-described processing, the light receiving control unit A11012 obtains images captured by the light receiving unit A12501 (front camera) and the light receiving unit A12502 (back camera).

Next, the light receiving control unit A11012 obtains an illuminance change of lighting from the captured images, in other words, performs decoding (SA12606).

Next, the light receiving control unit A11012 stores the ID obtained by the decoding, to the ID storage unit (SA12607).

As described above, the light receiving control unit A11012 can select a light receiving unit (image capturing unit) according to an attitude of the mobile terminal A11011. It is therefore possible to select the most appropriate light receiving unit (front camera) for a lighting device that looks at

the mobile terminal from the above (in other words, looks down at a floor plan of a building), or select the most appropriate light receiving unit (back camera) for a lighting device that looks at a rack and other subjects in front in a horizontal direction.

Embodiment 3

The details of the structure and the flow of the light receiving control unit A**11012** are not limited to those described in Embodiment 2. In Embodiment 3, a structure and a flow of the light receiving control unit A**11012** which are different from those described in Embodiment 2 are described. The other structure is the same as described in Embodiment 1 and therefore not described again below.

[Detailed Structure of Light Receiving Control Unit A**11012**]

First, a detailed structure of the light receiving control unit A**11012** according to Embodiment 3 is described.

FIG. **27** is a diagram illustrating the detailed structure of the light receiving control unit according to Embodiment 3.

The light receiving control unit A**11012** according to Embodiment 3 includes a first light receiving unit A**12701**, a second light receiving unit A**12702**, a selector A**12703**, a timer control unit A**12704**, a light receiving signal storage unit A**12705**, a decoding unit A**12706**, and a threshold storage unit A**12707**.

The light receiving unit A**12701** corresponds to, for example, the front camera A**1202** (first image capturing unit) according to Embodiment 1, and the light receiving unit A**12702** corresponds to, for example, the back camera A**1203** (second image capturing unit) according to Embodiment 1.

The selector A**12703** selects one of these two light receiving units to be operated.

The timer control unit A**12704** provides the selector A**12703** with information necessary in the selection.

The light receiving signal storage unit A**12705** stores light receiving signal obtained from the first light receiving unit A**12701** or the second light receiving unit A**12702** via the selector A**12703**.

The decoding unit A**12706** reads the light receiving signal from the light receiving signal storage unit A**12705**, then decodes the light receiving signal to an ID and stores the resulting ID to the ID storage unit A**11013**.

The threshold storage unit A**12707** previously holds a threshold **1** for a time period required from when the selector A**12703** selects the first light receiving unit A**12701** to start receiving light to when the selector A**12703** switches to the second light receiving unit A**12702** to receive light. The threshold storage unit A**12507** previously holds a threshold **2** for a time period required from when the selector A**12703** selects the second light receiving unit A**12702** to start receiving light to when the selector A**12703** switches to the first light receiving unit A**12701** to receive light.

[Processing of Light Receiving Control Unit]

Subsequently, the processing flow of the light receiving control unit A**11012** according to Embodiment 3 is described.

FIG. **28** is a flowchart of illuminance pattern detection performed by the light receiving control unit according to Embodiment 3.

First, after starting (SA**11501**), the light receiving control unit A**11012** confirms whether or not the timer control unit A**12704** is stopped (SA**12801**).

At SA**12801**, if the timer control unit A**12704** is not operated (yes at SA**12801**), the light receiving control unit A**11012** operates the timer control unit A**12704** and the first light receiving unit A**12701** (SA**12802**).

Next, at SA**12803**, if the first light receiving unit A**12701** is operating (yes at SA**12803**) and a time period of the first threshold has passed since the first light receiving unit A**12701** starts the operation (yes at SA**12804**), the light receiving control unit A**11012** stops the first light receiving unit A**12701** and starts the second light receiving unit A**12702** for a balanced use of these light receiving units (SA**12806**).

On the other hand, if the first light receiving unit A**12701** is stopped and therefore the second light receiving unit A**12702** is operating (no at SA**12803**), and a time period of the second threshold has passed since the second light receiving unit A**12702** starts the operation (yes at SA**12805**), then the second light receiving unit A**12702** is stopped and the first light receiving unit A**12701** is operated for a balanced use of these light receiving units (SA**12807**).

Next, the light receiving control unit A**11012** captures still pictures (SA**12608**). More specifically, in the above-described processing, the light receiving control unit A**11012** obtains images captured by the first light receiving unit A**12501** or the second light receiving unit A**12502**.

Next, the light receiving control unit A**11012** obtains an illuminance change of lighting from the captured images, in other words, performs decoding (SA**12609**).

Next, the light receiving control unit A**11012** stores the ID obtained by the decoding, to the ID storage unit A**11013** (SA**12610**).

As described above, the light receiving control unit A**11012** selects a light receiving unit (image capturing unit) at predetermined intervals. As a result, for example, in the case where a watch-type device as illustrated in FIG. **9** is horizontally held, it is possible to obtain, in a balanced manner, an ID from the ceiling light A**1904** on the ceiling and an ID from the base light A**1905** provided on a rack.

According to the present embodiment, the light receiving control unit A**11012** may further include an acceleration detection unit. In this case, if it is expected that the display surface of the watch-type device is not parallel to the ground, in other words, the user does not look at the display surface of the watch-type device, the light receiving control unit A**11012** may stop the first light receiving unit A**12501** and the second light receiving unit A**12502** to save power consumption.

Embodiment 4

According to Embodiment 4, the description is given for an example where a technique of detecting a line of sight is applied to Embodiment 1 to more appropriately reflect user's intention to the display unit A**11018**.

FIG. **29** is a diagram illustrating an example of a situation of using a mobile terminal for detecting a movement of a line of sight according to Embodiment 4.

As illustrated in FIG. **29**, when a user holds a mobile terminal A**12901** by a hand and causes the back side of the mobile terminal A**12901** to face a rack A**12903**, a display unit of the mobile terminal A**12901** displays information of the rack A**12903**. According to the present embodiment, if the user's line of sight looks at the right of the rack A**12901** in the above situation, the mobile terminal A**12901** can detect the user's line of sight by image recognition. Then, it is determined that "what the user looks at is not the rack A**12901** but a rack A**12905** located on the right side of the rack A**12901**", and therefore information related to the rack A**12905** is displayed on the display unit of the mobile terminal A**12901**.

As described above, in the present embodiment, an object to be displayed is selected in consideration of not only a lighting device in front of the mobile terminal A**12901** but

also a user's line of sight. As a result, it is possible to examine information to which user's intention is more appropriately reflected.

[Structure of Mobile Terminal A12901]

Subsequently, the structure of the mobile terminal A12901 according to Embodiment 4 is described.

FIG. 30 is a diagram illustrating an example of a structure of a mobile terminal according to Embodiment 4. It should be noted that, in FIG. 30, structural elements overlapping in Embodiment 1, in other words, the same structural elements as illustrated in FIG. 10, are assigned with the same reference numerals.

A mobile terminal A12901 illustrated in FIG. 30 includes a light receiving control unit A13002, an ID storage unit A11013, a DB management unit A13003, a product information storage unit A11016, a map information storage unit A11017, a display unit A11018, a state management unit A11019, an UI unit A11020, and a line-of-sight information storage unit A13001. Furthermore, the mobile terminal A12901 is connected to the server device A13004 by wireless communication.

The light receiving control unit A13002 detects an illuminance pattern of the light emitting unit A11007 and an illuminance pattern of the light emitting unit A11011, then converts the detected patterns to IDs, and stores the IDs to the ID storage unit A11013. In the case of the present embodiment, since the light receiving control unit A13002 detects an illuminance pattern of the light emitting unit A11007 or the light emitting unit A11011, the ID stored in the ID storage unit A11013 is identical to either an ID stored in the ID storage unit A11004 or an ID stored in the ID storage unit A11008.

Furthermore, the light receiving control unit A13002 detects, by an internal light receiving function in the light receiving control unit A13002, line-of-sight classification information indicating to which the user's line of sight is classified among "front, right, and left", and eventually stores the detected classification result to the line-of-sight information storage unit A13001.

The other structure is the same as described in Embodiment 10, so that it is not described in detail again.

[Operation Flow of DB Management Unit A13003]

Next, a flow of a DB management unit A13003 is described. In the first embodiment, SA11801 in FIG. 18 according to Embodiment 1 is described in more detail. Since the other steps are the same as described previously, the following mainly describes a detailed flow of SA11801.

FIG. 31 is a flowchart of inquiry performed by the DB management unit according to Embodiment 4. FIG. 32 illustrates an example of a structure of pieces of information managed by the DB in the server device according to Embodiment 4.

First, the DB management unit A13003 starts processing for requesting the server device A11015 to transmit a product image (SA11801).

Then, the DB management unit A13003 inquires the server device about an ID and line-of-sight classification information (SA13201). More specifically, the DB management unit A13003 reads the ID from the ID storage unit A11013, and reads the line-of-sight classification information from the line-of-sight information storage unit A13001. Furthermore, the DB management unit A13003 requests the server device A11015 for product information. In this case, the ID of the base light is transmitted to the server device A11015, and the line-of-sight classification information stored in the line-of-sight information storage unit A13001 is also transmitted to the server device A11015.

Next, the server device A11015 searches the held DB for the ID (SA13202). More specifically, the server device A11015 holds a DB as illustrated in FIG. 32, and searches a column A13102 of the DB for the received ID.

At SA13202, if the ID is found in the DB (yes at SA13203), then the server device A11015 searches a row of the DB according to the ID and the line-of-sight classification information (SA13205), and confirms whether or not there is a rack identifier corresponding to the line-of-sight classification information (SA13206). More specifically, if the corresponding row is found in the column A13102 of the DB, the server device A11015 extracts a rack identifier from the row. Here, if the line-of-sight classification information indicates "front", a rack identifier is obtained with reference to a column A13101 in the corresponding row. If the line-of-sight classification information indicates "left", a rack identifier is obtained with reference to a column A13103 in the corresponding row. If the line-of-sight classification information indicates "right", a rack identifier is obtained with reference to a column A13104 in the corresponding row.

Next, the server device A11015 searches for a row corresponding to the obtained rack identifier (SA13208), and notifies rack information indicated in the rack information column in the corresponding row (SA13209). More specifically, the server device A11015 searches the A13101 column for the obtained rack identifier, and notifies rack information A13105 in the corresponding row to the DB management unit A13003 in the mobile terminal A12901. For example, if an ID having a value of 200 and line-of-sight classification information indicating "right" are received and the ID having a value of 200 is searched in lighting ID A13102, the ID is in the first row. Since a rack identifier A13104 on the right side of the first row is 101, rack information A13105 in a row in which a rack identifier A13101 is 101, namely, rack information 2, is transmitted to the mobile terminal A12901.

Then, the DB management unit A13003 of the mobile terminal A12901 stores the obtained product information to the product information storage unit A11016, and sets the validity flag A11301 of the map information storage unit A11017 to FALSE, sets the validity flag of the product information storage unit A11016 to TRUE, and sets the error flag A11601 to FALSE.

Here, at SA13206, if no rack identifier is extracted based on the received ID and the line-of-sight classification information although the ID is detected from the column A13102 (no at SA13206), then the server device A11015 notifies the rack information A13105 of the row in which the received ID is found, to the DB management unit A13003 in the mobile terminal A12901 (SA13207).

On the other hand, at SA13023, if the server device A11015 cannot detect the received ID from the column A13102 (no at SA13203), the server device A11015 notifies the DB management unit A13003 in the mobile terminal A12901 of that there is no corresponding ID (SA13204). It should be noted that, if, for example, the ID transmitted to the server device A11015 is an invalid ID that is not related to any of the ceiling light and the base lights, the DB management unit A13003 sets the validity flag A11301 of the map information storage unit A11017 to FALSE, sets the validity flag of the product information storage unit A11016 to FALSE, and sets the error flag A11601 to TRUE.

As described above, according to the present embodiment, the mobile terminal including the communication device is further capable of detecting a user's line of sight. More specifically, if an orientation of the mobile terminal is substantially perpendicular to the ground, the back camera is selected

to perform visible light communication with the first device that emits visible light, and the front camera is used to detect the user's line of sight.

As a result, the back camera is used to perform visible light communication with the first device that is in front of the user and emits visible light, the product information of the first product rack to which the first device is provided is obtained. If the second product rack in the detected user's line of sight is not the first product rack, it is possible to display product information of the second product rack instead of the product information of the first product rack.

Embodiment 5

Embodiment 5 is based on Embodiment 4 to more clarify the structure of the light receiving control unit **A11012**.

FIG. **33** is a diagram illustrating the detailed structure of the light receiving control unit according to Embodiment 5.

As illustrated in FIG. **33**, the light receiving control unit **A11012** according to Embodiment 5 includes a light receiving unit **A12501**, a light receiving unit **A12502**, a selector **A12503**, an acceleration detection unit **A12504**, a light receiving signal storage unit **A12505**, a decoding unit **A12506**, a threshold storage unit **A12507**, and a line-of-sight detection unit **A13301**. It should be noted that the same reference numerals in FIG. **25** are assigned to the identical structural elements, and therefore the detailed description of the identical structural elements are not given below.

The light receiving unit **A12501** corresponds to, for example, the front camera **A1202** (first image capturing unit) according to Embodiment 1, and the light receiving unit **A12502** corresponds to, for example, the back camera **A1203** (second image capturing unit) according to Embodiment 1. It should be noted that, according to the present embodiment, the light receiving unit **A12501** is a video imaging device such as a camera device.

The selector **A12503** selects one of the two light receiving units to be operated.

The acceleration detection unit **A12504** detects an acceleration of the mobile terminal **A12901** to provide the selector **A12503** with information necessary in the selection.

The light receiving signal storage unit **A12505** stores light receiving signal obtained from the light receiving unit **A12501** or the light receiving unit **A12502** via the selector **A12503**.

The decoding unit **A12506** reads the light receiving signal from the light receiving signal storage unit **A12505**, then decodes the light receiving signal to an ID and stores the resulting ID to the ID storage unit **A11013**.

The threshold storage unit **A12507** previously holds a first threshold and a second threshold. These thresholds are used to determine, based on an acceleration detected by the selector **A12503**, whether or not the mobile terminal **A12901** including the light receiving control unit **A11012** is parallel to the ground.

The line-of-sight detection unit **A13301** receives a video signal from the light receiving unit **A12501**, and detects a position of a user's line of sight and stores line-of-sight classification information to the line-of-sight information storage unit **A13001**.

Embodiment 6

Embodiment 6 is based on Embodiment 4 to more clarify the structure of the light receiving control unit **A11012**.

FIG. **34** is a diagram illustrating the detailed structure of the light receiving control unit according to Embodiment 6.

As illustrated in FIG. **34**, the light receiving control unit **A11012** according to Embodiment 6 includes a light receiving unit **A12501**, a light receiving unit **A12502**, a selector **A12503**, an acceleration detection unit **A12504**, a light receiving signal storage unit **A12505**, a decoding unit **A12506**, a threshold storage unit **A12507**, an image capturing unit **A13401**, and a line-of-sight detection unit **A13402**. It should be noted that the same reference numerals in FIG. **25** are assigned to the identical structural elements, and therefore the detailed description of the identical structural elements are not given below.

According to the present embodiment, the light receiving unit **A12501** is assumed to be a sensor device such as an illuminance sensor. The light receiving unit **A12502** corresponds to, for example, the out-camera **A1203** (second image capturing unit) according to Embodiment 1.

The selector **A12503** selects one of these two light receiving units to be operated.

The acceleration detection unit **A12504** detects an acceleration of the mobile terminal **A12901** to provide the selector **A12503** with information necessary in the selection.

The light receiving signal storage unit **A12505** stores light receiving signal obtained from the light receiving unit **A12501** or the light receiving unit **A12502** via the selector **A12503**.

The decoding unit **A12506** reads the light receiving signal from the light receiving signal storage unit **A12505**, then decodes the light receiving signal to an ID and stores the resulting ID to the ID storage unit **A11013**.

The threshold storage unit **A12507** previously holds a first threshold and a second threshold. These thresholds are used to determine, based on an acceleration detected by the selector **A12503**, whether or not the mobile terminal **A12901** including the light receiving control unit **A11012** is parallel to the ground.

The image capturing unit **A13401** is a video imaging device such as a camera device.

The line-of-sight detection unit **A13402** receives a video signal from the light receiving unit **A13401**, and detects a position of a user's line of sight and stores resulting line-of-sight classification information to the line-of-sight information storage unit **A13001**.

As described above, according to the present embodiment, it is possible to provide a communication terminal and a communication method which are capable of presenting information to which a current position and intension of a user are more appropriately reflected according to an attitude of a mobile terminal.

Embodiment 7

The following describes Embodiment 7.

(Observation of Luminance of Light Emitting Unit)

The following proposes an imaging method in which, when capturing one image, all imaging elements are not exposed simultaneously but the times of starting and ending the exposure differ between the imaging elements. FIG. **35** illustrates an example of imaging where imaging elements arranged in a line are exposed simultaneously, with the exposure start time being shifted in order of lines. Here, the simultaneously exposed imaging elements are referred to as "exposure line", and the line of pixels in the image corresponding to the imaging elements is referred to as "bright line".

In the case of capturing a blinking light source shown on the entire imaging elements using this imaging method, bright lines (lines of brightness in pixel value) along exposure lines appear in the captured image as illustrated in FIG. **36**. By

recognizing this bright line pattern, the luminance change of the light source at a speed higher than the imaging frame rate can be estimated. Hence, transmitting a signal as the luminance change of the light source enables communication at a speed not less than the imaging frame rate. In the case where the light source takes two luminance values to express a signal, the lower luminance value is referred to as "low" (LO), and the higher luminance value is referred to as "high" (HI). The low may be a state in which the light source emits no light, or a state in which the light source emits weaker light than in the high.

By this method, information transmission is performed at a speed higher than the imaging frame rate.

In the case where the number of exposure lines whose exposure times do not overlap each other is 20 in one captured image and the imaging frame rate is 30 fps, it is possible to recognize a luminance change in a period of 1.67 millisecond. In the case where the number of exposure lines whose exposure times do not overlap each other is 1000, it is possible to recognize a luminance change in a period of $\frac{1}{30000}$ second (about 33 microseconds). Note that the exposure time is set to less than 10 milliseconds, for example.

FIG. **36** illustrates a situation where, after the exposure of one exposure line ends, the exposure of the next exposure line starts.

In this situation, when transmitting information based on whether or not each exposure line receives at least a predetermined amount of light, information transmission at a speed of fl bits per second at the maximum can be realized where f is the number of frames per second (frame rate) and l is the number of exposure lines constituting one image.

Note that faster communication is possible in the case of performing time-difference exposure not on a line basis but on a pixel basis.

In such a case, when transmitting information based on whether or not each pixel receives at least a predetermined amount of light, the transmission speed is flm bits per second at the maximum, where m is the number of pixels per exposure line.

If the exposure state of each exposure line caused by the light emission of the light emitting unit is recognizable in a plurality of levels as illustrated in FIG. **37**, more information can be transmitted by controlling the light emission time of the light emitting unit in a shorter unit of time than the exposure time of each exposure line.

In the case where the exposure state is recognizable in Elv levels, information can be transmitted at a speed of flElv bits per second at the maximum.

Moreover, a fundamental period of transmission can be recognized by causing the light emitting unit to emit light with a timing slightly different from the timing of exposure of each exposure line.

FIG. **38** illustrates a situation where, before the exposure of one exposure line ends, the exposure of the next exposure line starts. That is, the exposure times of adjacent exposure lines partially overlap each other. This structure has the feature (1): the number of samples in a predetermined time can be increased as compared with the case where, after the exposure of one exposure line ends, the exposure of the next exposure line starts. The increase of the number of samples in the predetermined time leads to more appropriate detection of the light signal emitted from the light transmitter which is the subject. In other words, the error rate when detecting the light signal can be reduced. The structure also has the feature (2): the exposure time of each exposure line can be increased as compared with the case where, after the exposure of one exposure line ends, the exposure of the next exposure line starts. Accordingly, even in the case where the subject is dark, a brighter image can be obtained, i.e. the S/N ratio can be improved. Here, the structure in which the exposure times of adjacent exposure lines partially overlap each other does not need to be applied to all exposure lines, and part of the exposure lines may not have the structure of partially overlapping in exposure time. By keeping part of the exposure lines from partially overlapping in exposure time, the occurrence of an intermediate color caused by exposure time overlap is suppressed on the imaging screen, as a result of which bright lines can be detected more appropriately.

In this situation, the exposure time is calculated from the brightness of each exposure line, to recognize the light emission state of the light emitting unit.

Note that, in the case of determining the brightness of each exposure line in a binary fashion of whether or not the luminance is greater than or equal to a threshold, it is necessary for the light emitting unit to continue the state of emitting no light for at least the exposure time of each line, to enable the no light emission state to be recognized.

FIG. **39** illustrates the influence of the difference in exposure time in the case where the exposure start time of each exposure line is the same. In **7500***a*, the exposure end time of one exposure line and the exposure start time of the next exposure line are the same. In **7500***b*, the exposure time is longer than that in **7500***a*. The structure in which the exposure times of adjacent exposure lines partially overlap each other as in **7500***b* allows a longer exposure time to be used. That is, more light enters the imaging element, so that a brighter image can be obtained. In addition, since the imaging sensitivity for capturing an image of the same brightness can be reduced, an image with less noise can be obtained. Communication errors are prevented in this way.

FIG. **40** illustrates the influence of the difference in exposure start time of each exposure line in the case where the exposure time is the same. In **7501***a*, the exposure end time of one exposure line and the exposure start time of the next exposure line are the same. In **7501***b*, the exposure of one exposure line ends after the exposure of the next exposure line starts. The structure in which the exposure times of adjacent exposure lines partially overlap each other as in **7501***b* allows more lines to be exposed per unit time. This increases the resolution, so that more information can be obtained. Since the sample interval (i.e. the difference in exposure start time) is shorter, the luminance change of the light source can be estimated more accurately, contributing to a lower error rate. Moreover, the luminance change of the light source in a shorter time can be recognized. By exposure time overlap, light source blinking shorter than the exposure time can be recognized using the difference of the amount of exposure between adjacent exposure lines.

As described with reference to FIGS. **39** and **40**, in the structure in which each exposure line is sequentially exposed so that the exposure times of adjacent exposure lines partially overlap each other, the communication speed can be dramatically improved by using, for signal transmission, the bright line pattern generated by setting the exposure time shorter than in the normal imaging mode. Setting the exposure time in visible light communication to less than or equal to $\frac{1}{480}$ second enables an appropriate bright line pattern to be generated. Here, it is necessary to set (exposure time)$<\frac{1}{8}\times f$, where f is the frame frequency. Blanking during imaging is half of one frame at the maximum. That is, the blanking time is less than or equal to half of the imaging time. The actual imaging time is therefore $\frac{1}{2}f$ at the shortest. Besides, since 4-value information needs to be received within the time of $\frac{1}{2}f$, it is necessary to at least set the exposure time to less than

1/(2f×4). Given that the normal frame rate is less than or equal to 60 frames per second, by setting the exposure time to less than or equal to 1/480 second, an appropriate bright line pattern is generated in the image data and thus fast signal transmission is achieved.

FIG. **41** illustrates the advantage of using a short exposure time in the case where each exposure line does not overlap in exposure time. In the case where the exposure time is long, even when the light source changes in luminance in a binary fashion as in **7502***a*, an intermediate-color part tends to appear in the captured image as in **7502***e*, making it difficult to recognize the luminance change of the light source. By providing a predetermined non-exposure vacant time (predetermined wait time) t_{D2} from when the exposure of one exposure line ends to when the exposure of the next exposure line starts as in **7502***d*, however, the luminance change of the light source can be recognized more easily. That is, a more appropriate bright line pattern can be detected as in **7502***f*. The provision of the predetermined non-exposure vacant time is possible by setting a shorter exposure time t_E than the time difference t_D between the exposure start times of the exposure lines, as in **7502***d*. In the case where the exposure times of adjacent exposure lines partially overlap each other in the normal imaging mode, the exposure time is shortened from the normal imaging mode so as to provide the predetermined non-exposure vacant time. In the case where the exposure times of adjacent exposure lines partially overlap each other in the normal imaging mode, the exposure time is shortened from the normal imaging mode so as to provide the predetermined non-exposure vacant time. In the case where the exposure end time of one exposure line and the exposure start time of the next exposure line are the same in the normal imaging mode, too, the exposure time is shortened so as to provide the predetermined non-exposure time. Alternatively, the predetermined non-exposure vacant time (predetermined wait time) t_{D2} from when the exposure of one exposure line ends to when the exposure of the next exposure line starts may be provided by increasing the interval t_D between the exposure start times of the exposure lines, as in **7502***g*. This structure allows a longer exposure time to be used, so that a brighter image can be captured. Moreover, a reduction in noise contributes to higher error tolerance. Meanwhile, this structure is disadvantageous in that the number of samples is small as in **7502***h*, because fewer exposure lines can be exposed in a predetermined time. Accordingly, it is desirable to use these structures depending on circumstances. For example, the estimation error of the luminance change of the light source can be reduced by using the former structure in the case where the imaging object is bright and using the latter structure in the case where the imaging object is dark.

Here, the structure in which the exposure times of adjacent exposure lines partially overlap each other does not need to be applied to all exposure lines, and part of the exposure lines may not have the structure of partially overlapping in exposure time. Moreover, the structure in which the predetermined non-exposure vacant time (predetermined wait time) is provided from when the exposure of one exposure line ends to when the exposure of the next exposure line starts does not need to be applied to all exposure lines, and part of the exposure lines may have the structure of partially overlapping in exposure time. This makes it possible to take advantage of each of the structures. Furthermore, the same reading method or circuit may be used to read a signal in the normal imaging mode in which imaging is performed at the normal frame rate (30 fps, 60 fps) and the visible light communication mode in which imaging is performed with the exposure time less than or equal to 1/480 second for visible light communication. The use of the same reading method or circuit to read a signal eliminates the need to employ separate circuits for the normal imaging mode and the visible light communication mode. The circuit size can be reduced in this way.

FIG. **42** illustrates the relation between the minimum change time t_S of light source luminance, the exposure time t_E, the time difference t_D between the exposure start times of the exposure lines, and the captured image. In the case where $t_E+t_D<t_S$, imaging is always performed in a state where the light source does not change from the start to end of the exposure of at least one exposure line. As a result, an image with clear luminance is obtained as in **7503***d*, from which the luminance change of the light source is easily recognizable. In the case where $2t_E>t_S$, a bright line pattern different from the luminance change of the light source might be obtained, making it difficult to recognize the luminance change of the light source from the captured image.

FIG. **43** illustrates the relation between the transition time t_T of light source luminance and the time difference t_D between the exposure start times of the exposure lines. When t_D is large as compared with t_T, fewer exposure lines are in the intermediate color, which facilitates estimation of light source luminance. It is desirable that $t_D>t_T$, because the number of exposure lines in the intermediate color is two or less consecutively. Since t_T is less than or equal to 1 microsecond in the case where the light source is an LED and about 5 microseconds in the case where the light source is an organic EL device, setting t_D to greater than or equal to 5 microseconds facilitates estimation of light source luminance.

FIG. **44** illustrates the relation between the high frequency noise t_{HT} of light source luminance and the exposure time t_E. When t_E is large as compared with t_{HT}, the captured image is less influenced by high frequency noise, which facilitates estimation of light source luminance. When t_E is an integral multiple of t_{HT}, there is no influence of high frequency noise, and estimation of light source luminance is easiest. For estimation of light source luminance, it is desirable that $t_E>t_{HT}$. High frequency noise is mainly caused by a switching power supply circuit. Since t_{HT} is less than or equal to 20 microseconds in many switching power supplies for lightings, setting t_E to greater than or equal to 20 microseconds facilitates estimation of light source luminance.

FIG. **45** is a graph representing the relation between the exposure time t_E and the magnitude of high frequency noise when t_{HT} is 20 microseconds. Given that t_{HT} varies depending on the light source, the graph demonstrates that it is efficient to set t_E to greater than or equal to 15 microseconds, greater than or equal to 35 microseconds, greater than or equal to 54 microseconds, or greater than or equal to 74 microseconds, each of which is a value equal to the value when the amount of noise is at the maximum. Though t_E is desirably larger in terms of high frequency noise reduction, there is also the above-mentioned property that, when t_E is smaller, an intermediate-color part is less likely to occur and estimation of light source luminance is easier. Therefore, t_E may be set to greater than or equal to 15 microseconds when the light source luminance change period is 15 to 35 microseconds, to greater than or equal to 35 microseconds when the light source luminance change period is 35 to 54 microseconds, to greater than or equal to 54 microseconds when the light source luminance change period is 54 to 74 microseconds, and to greater than or equal to 74 microseconds when the light source luminance change period is greater than or equal to 74 microseconds.

FIG. **46** illustrates the relation between the exposure time t_E and the recognition success rate. Since the exposure time t_E is relative to the time during which the light source luminance

is constant, the horizontal axis represents the value (relative exposure time) obtained by dividing the light source luminance change period t_S by the exposure time t_E. It can be understood from the graph that the recognition success rate of approximately 100% can be attained by setting the relative exposure time to less than or equal to 1.2. For example, the exposure time may be set to less than or equal to approximately 0.83 millisecond in the case where the transmission signal is 1 kHz. Likewise, the recognition success rate greater than or equal to 95% can be attained by setting the relative exposure time to less than or equal to 1.25, and the recognition success rate greater than or equal to 80% can be attained by setting the relative exposure time to less than or equal to 1.4. Moreover, since the recognition success rate sharply decreases when the relative exposure time is about 1.5 and becomes roughly 0% when the relative exposure time is 1.6, it is necessary to set the relative exposure time not to exceed 1.5. After the recognition rate becomes 0% at **7507***c*, it increases again at **7507***d*, **7507***e*, and **7507***f*. Accordingly, for example to capture a bright image with a longer exposure time, the exposure time may be set so that the relative exposure time is 1.9 to 2.2, 2.4 to 2.6, or 2.8 to 3.0. Such an exposure time may be used, for instance, as an intermediate mode in FIG. **48**.

Depending on imaging devices, there is a time (blanking) during which no exposure is performed, as illustrated in FIG. **47**.

In the case where there is blanking, the luminance of the light emitting unit during the time cannot be observed.

A transmission loss caused by blanking can be prevented by the light emitting unit repeatedly transmitting the same signal two or more times or adding error correcting code.

To prevent the same signal from being transmitted during blanking every time, the light emitting unit transmits the signal in a period that is relatively prime to the period of image capture or a period that is shorter than the period of image capture.

Embodiment 8

FIG. **49** is a diagram illustrating a service provision system using the reception method described in any of the foregoing embodiments.

First, a company A ex**8000** managing a server ex**8002** is requested to distribute information to a mobile terminal, by another company B or individual ex**8001**. For example, the distribution of detailed advertisement information, coupon information, map information, or the like to the mobile terminal that performs visible light communication with a signage is requested. The company A ex**8000** managing the server manages information distributed to the mobile terminal in association with arbitrary ID information. A mobile terminal ex**8003** obtains ID information from a subject ex**8004** by visible light communication, and transmits the obtained ID information to the server ex**8002**. The server ex**8002** transmits the information corresponding to the ID information to the mobile terminal, and counts the number of times the information corresponding to the ID information is transmitted. The company A ex**8000** managing the server charges the fee corresponding to the count, to the requesting company B or individual ex**8001**. For example, a larger fee is charged when the count is larger.

FIG. **50** is a flowchart illustrating service provision flow.

In Step ex**8000**, the company A managing the server receives the request for information distribution from another company B. In Step ex**8001**, the information requested to be distributed is managed in association with the specific ID information in the server managed by the company A. In Step ex**8002**, the mobile terminal receives the specific ID information from the subject by visible light communication, and transmits it to the server managed by the company A. The visible light communication method has already been described in detail in the other embodiments, and so its description is omitted here. The server transmits the information corresponding to the specific ID information received from the mobile terminal, to the mobile terminal. In Step ex**8003**, the number of times the information is distributed is counted in the server. Lastly, in Step ex**8004**, the fee corresponding to the information distribution count is charged to the company B. By such charging according to the count, the appropriate fee corresponding to the advertising effect of the information distribution can be charged to the company B.

FIG. **51** is a flowchart illustrating service provision in another example. The description of the same steps as those in FIG. **50** is omitted here.

In Step ex**8008**, whether or not a predetermined time has elapsed from the start of the information distribution is determined. In the case of determining that the predetermined time has not elapsed, no fee is charged to the company B in Step ex**8011**. In the case of determining that the predetermined time has elapsed, the number of times the information is distributed is counted in Step ex**8009**. In Step ex**8010**, the fee corresponding to the information distribution count is charged to the company B. Since the information distribution is performed free of charge within the predetermined time, the company B can receive the accounting service after checking the advertising effect and the like.

FIG. **52** is a flowchart illustrating service provision in another example. The description of the same steps as those in FIG. **51** is omitted here.

In Step ex**8014**, the number of times the information is distributed is counted. In the case of determining that the predetermined time has not elapsed from the start of the information distribution in Step ex**8015**, no fee is charged in Step ex**8016**. In the case of determining that the predetermined time has elapsed, on the other hand, whether or not the number of times the information is distributed is greater than or equal to a predetermined number is determined in Step ex**8017**. In the case where the number of times the information is distributed is less than the predetermined number, the count is reset, and the number of times the information is distributed is counted again. In this case, no fee is charged to the company B regarding the predetermined time during which the number of times the information is distributed is less than the predetermined number. In the case where the count is greater than or equal to the predetermined number in Step ex**8017**, the count is reset and started again in Step ex**8018**. In Step ex**8019**, the fee corresponding to the count is charged to the company B. Thus, in the case where the count during the free distribution time is small, the free distribution time is provided again. This enables the company B to receive the accounting service at an appropriate time. Moreover, in the case where the count is small, the company A can analyze the information and, for example when the information is out of season, suggest the change of the information to the company B. In the case where the free distribution time is provided again, the time may be shorter than the predetermined time provided first. The shorter time than the predetermined time provided first reduces the burden on the company A. Further, the free distribution time may be provided again after a fixed time period. For instance, if the information is influenced by seasonality, the free distribution time is provided again after the fixed time period until the new season begins.

Note that the charge fee may be changed according to the amount of data, regardless of the number of times the information is distributed. Distribution of a predetermined amount of data or more may be charged, while distribution is free of charge within the predetermined amount of data. The charge fee may be increased with the increase of the amount of data. Moreover, when managing the information in association with the specific ID information, a management fee may be charged. By charging the management fee, it is possible to determine the fee upon requesting the information distribution.

INDUSTRIAL APPLICABILITY

The communication method and the like according to the present invention are capable of securely and actively obtaining information except image. Therefore, they are suitable for various uses, such as transfer of information with image and information transmission, in any situations, since the active obtaining allows not only apparatuses in home, such as television sets, PCs, and tablet terminals, but also signage, information terminals, and information display apparatuses outside home to securely obtain necessary information by a necessary amount.

We claim:

1. A communication method used in a terminal that includes a front camera and a back camera, the communication method comprising:

switching between the front camera and the back camera according to an orientation of the terminal; and

performing visible light communication by using the front camera or the back camera, which is selected in the switching,

wherein the performing of visible light communication includes:

capturing a first subject that is changing in luminance by using the front camera and obtaining a first image when the front camera is used;

capturing a second subject by using the back camera and obtaining a second image when the back camera is used; and

obtaining specified information that is related to the first subject or the second subject.

2. The communication method according to claim **1**,

wherein when the orientation of the terminal is substantially parallel to ground, the performing of visible light communication includes performing, by using the front camera selected in the switching, visible light communication with the second subject which is located above the user and emits visible light.

3. The communication method according to claim **2**,

wherein when the orientation of the terminal is substantially perpendicular to ground, the performing of visible light communication includes performing, by using the back camera selected in the switching, visible light communication with the first subject which is located in front of a user and emits visible light.

4. The communication method according to claim **1**,

wherein the terminal is included in a watch,

the front camera is provided on a front surface of the watch, and the back camera is provided on a side surface of the watch, the front surface having a display that displays a time of the watch, and

when the display of the watch is substantially parallel to ground, the performing of visible light communication includes:

performing, by using the front camera, visible light communication with the second subject which is located above the user and emits visible light; and

performing, by using the back camera, visible light communication with the first subject which is located in front of the user and emits visible light.

5. The communication method according to claim **1**,

wherein the performing of visible light communication includes inquiring a server about the specified information, thereby obtaining information related to the first subject or the second subject corresponding to the specified information, and

when no information corresponds to the specified information as a result of the inquiring the server, the performing of visible light communication further includes displaying, on a display of the terminal, an error notification indicating that no information is related to the first subject or the second subject.

6. The communication method according to claim **2**, further comprising:

performing, by using the front camera selected in the switching, visible light communication with the second subject which is located above the user and emits visible light, thereby obtaining information of the first subject; and displaying the information on a display of the terminal, and

changing the information displayed on the display of the terminal, wherein in the changing, the information to be displayed on the display is changed by user's flicking on the display.

7. A communication apparatus, comprising:

a front camera;

a back camera;

a processor; and

a memory having therein a program, the program causing the processor to execute operations including:

switching between the front camera and the back camera according to an orientation of the terminal; and

performing visible light communication by using the front camera or the back camera, which is selected in the switching,

wherein the performing of visible light communication includes:

capturing a first subject that is changing in luminance by using the front camera and obtaining a first image when the front camera is used;

capturing a second subject by using the back camera and obtaining a second image when the back camera is used; and

obtaining specified information that is related to the first subject or the second subject.

8. A non-transitory computer-readable recording medium storing a program for performing visible light communication, the visible light communication program causing a computer to execute:

switching between the front camera and the back camera according to an orientation of the terminal; and

performing visible light communication by using the front camera or the back camera, which is selected in the switching,

wherein the performing of visible light communication includes:

capturing a first subject that is changing in luminance by using the front camera and obtaining a first image when the front camera is used;

capturing a second subject by using the back camera and obtaining a second image when the back camera is used; and

obtaining specified information that is related to the first subject or the second subject.

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